public inspection in the DOE Public Docket Room at 2000 M Street, N.W., Washington, D.C. Any applicant who believes that his Application contains confidential information must so indicate on the first page of his Application and submit two additional copies of his Application from which the information that the applicant claims is confidential has been deleted, together with a statement specifying why any such information is privileged or confidential.

(b) The contents of an Application for Refund shall be specified in the final Decision and Order referred to in Section 205.282(c). A filing deadline for Applications shall also be specified in the final Decision and Order, and shall be no less than 90 days after the publication of the Order in the FEDERAL REGISTER.

(c) Each Application shall be in writing and signed by the applicant, and shall indicate whether the applicant or any person acting on his instructions has filed or intends to file any other Application or claim of whatever nature regarding the matters at issue in the underlying enforcement proceeding. Each Application shall also include a sworn statement by the applicant that all information in his Application is true and correct to the best of his knowledge and belief.

**§ 205.284 Processing of applications.**

(a) The Director of the Office of Hearings and Appeals may appoint an administrator to evaluate Applications under guidelines established by the Office of Hearings and Appeals. The administrator, if he is not a federal government employee, may be compensated from the funds referred to in the Remedial Order or Consent Order. The administrator may design and distribute an optional application form for the convenience of the applicants.

(b) The Office of Hearings and Appeals or its designee may initiate an investigation of any statement made in an Application and may require verification of any document submitted in support of a claim. In evaluating an Application, the Office of Hearings and Appeals or its designee may solicit and consider information obtained from any source and may on its own initiative convene a hearing or conference, if it determines that a hearing or conference will advance its evaluation of an Application.

(c) The Director of the Office of Hearings and Appeals or his designee shall conduct any hearing or conference convened with respect to an Application for Refund and shall specify the time and place for the hearing or conference and notify the applicant. The official conducting the hearing may administer oaths and affirmations, rule on the presentation of information, receive relevant information, dispose of procedural requests, determine the format of the hearing and otherwise regulate the course of the hearing. The provisions of § 205.8 of this Part which relate to subpoenas and witness fees shall apply to any hearing convened with respect to an application for refund, except that § 205.8(h) (2), (3) and (4) shall not apply.

(d) Upon consideration of an Application and other relevant information received during the course of a refund proceeding, the Director of the Office of Hearings and Appeals or his designee shall issue an order granting or denying the Application. The order shall contain a concise statement of the relevant facts and the legal basis for the order. A copy of the order, with such modification as is necessary to ensure the confidentiality of information protected from public disclosure by 18 U.S.C. 1905, may be obtained upon request by an applicant or any other person who participated in the proceeding.

**§ 205.285 Effect of failure to file a timely application.**

An Application for Refund must be filed no later than the date that the Office of Hearings and Appeals establishes pursuant to § 205.283(b). Any Application that is not filed on a timely basis may be summarily dismissed. The Office of Hearings and Appeals or its designee may, however, grant extensions of time for good cause shown. Any request for an extension of time must generally be submitted in writing prior to the deadline.

**§ 205.286 Limitations on amount of refunds.**

(a) The aggregate amount of all refunds approved by the Office of Hearings and Appeals or its designee in a given case shall not exceed the amount to be remitted pursuant to the relevant DOE enforcement order, plus any accumulated interest, reduced by the amount of any administrative costs approved by the Office of Hearings and Appeals. In the event that the aggregate amount of approved claims exceeds the aggregate amount of funds specified above, the Office of Hearings and Appeals may make refunds on a pro rata basis. The Office of Hearings and Appeals may delay payment of any refunds until all Applications have been processed.

(b) The Office of Hearings and Appeals may decline to consider Applications for refund amounts that, in view of the direct administrative costs involved, are too small to warrant individual consideration.

**§ 205.287 Escrow accounts, segregated funds and other guarantees.**

(a) In implementing the refund procedures specified in this Subpart, the Director of the Office of Hearings and Appeals or his designee shall issue an order providing for the custody of the funds to be tendered pursuant to the Remedial Order or Consent Order. This Order may require placement of the funds in an appropriate interest-bearing escrow account, retention of the funds by the firm in a segregated account under such terms and conditions as are specified by the DOE, or the posting of a sufficient bond or other guarantee to ensure payment.

(b) All costs and charges approved by the Office of Hearings and Appeals and incurred in connection with the processing of Applications for Refund or incurred by an escrow agent shall be paid from the amount of funds, including any accumulated interest, to be remitted pursuant to the Remedial Order or Consent Order.

(c) After the expenses referred to in subsection (b) have been satisfied and refunds distributed to successful applicants, any remaining funds remitted pursuant to the Remedial Order or Consent Order shall be deposited in the United States Treasury or distributed in any other manner specified in the Decision and Order referred to in Section 205.282(c).

(d) Funds contained in an escrow account, segregated fund, or guaranteed by other approved means shall be disbursed only upon written order of the Office of Hearings and Appeals.

**§ 205.288 Interim and ancillary orders.**

The Director of the Office of Hearings and Appeals or his designee may issue any interim or ancillary orders, or make any rulings or determinations to ensure that refund proceedings, including the actions of the administrator and the custodian of the funds involved in a refund proceeding, are conducted in an appropriate manner and are not unduly delayed.

[FR Doc. 79-4466 Filed 2-6-79; 2:28 pm]

federal register

FRIDAY, FEBRUARY 9, 1979

PART VI

# OFFICE OF PERSONNEL MANAGEMENT

■

# ANTIDISCRIMINATION POLICY: SPECIAL FEDERAL RECRUITMENT PROGRAM

[6325-01-M]

## OFFICE OF PERSONNEL MANAGEMENT

[5 CFR Part 720]

### ANTIDISCRIMINATION POLICY: SPECIAL FEDERAL RECRUITMENT PROGRAM

AGENCY: Office of Personnel Management.

ACTION: Proposed rulemaking.

SUMMARY: The Office of Personnel Management is proposing regulations to implement a special recruitment program, as required under 5 U.S.C. 7201, and in accordance with program guidelines established by the Equal Employment Opportunity Commission, which appear as an Appendix to this Part. These regulations are intended to provide a broad framework to ensure uniform, coherent and effective standards for the enforcement of government wide recruitment policies and programs, designed to eliminate the underrepresentation of minorities and women in Civil Service employment.

DATES: Comments must be received on or before March 21, 1979.

ADDRESS: Send written comments to the Director, Office of Affirmative Employment Programs, Office of Personnel Management, 1900 E Street N.W., Washington, D.C. 20415.

FOR FURTHER INFORMATION CONTACT:

Tom Dausch, 202-254-9470.

SUPPLEMENTARY INFORMATION: These regulations will be supplemented by further guidance developed by the Office of Personnel Management and issued through the Federal Personnel Manual system. Initial guidance will be issued at the same time final rules are published in the FEDERAL REGISTER.

The Office of Personnel Management has determined that it is not possible to give the public 60 days to comment on these proposed rules. The Civil Service Reform Act of 1978 requires publication of final regulations implementing the minority recruitment program, provided for in these proposed rules, not later than April 12, 1979. Within this constraint, the Office can provide only 40 days for public comment. The official who made this determination is Jule M. Sugarman, Deputy Director, Office of Personnel Management.

Section 7201 of title 5, U.S.C., referred to above was formerly section 7151. It was redesignated as section 7201 by section 703(a)(1) of the Civil Service Reform Act of 1978.

The Office of Personnel Management will hold a public hearing on these proposed rules at 2 p.m., Monday, February 26, 1979. Persons wishing to present testimony should contact Tom Dausch (202-254-9470) to be assigned a specific time on the agenda. The hearing will be held in Room 5H09, 1900 E Street N.W., Washington, D.C.

Accordingly, the Office of Personnel Management is proposing to add 5 CFR Part 720, as set forth below.

OFFICE OF PERSONNEL MANAGEMENT,
JAMES C. SPRY,
*Special Assistant to the Director.*

## PART 720—ANTIDISCRIMINATION POLICY: SPECIAL RECRUITMENT PROGRAM

### Subpart A—Principal Statutory Requirements

Sec.
720.101 Principal Statutory Requirements

### Subpart B—Special Recruitment Program

720.201 Regulatory requirements.
720.202 Definitions.
720.203 Responsibilities of the Office of Personnel Management.
720.204 Agency programs.
720.205 Agency plans.
720.206 Selection guidelines.
720.207 Reports.

AUTHORITY: 5 U.S.C. 7201.

### Subpart A—Principal Statutory Requirements

#### § 720.101 Principal statutory requirements.

This subpart incorporates the statutory antidiscrimination policy and the requirements for establishing and conducting a special recruitment program within the Federal civil service. The policy in 5 U.S.C. 7201(b) reads as follows: "It is the policy of the United States to insure equal employment opportunities for employees without discrimination because of race, color, religion, sex, or national origin. The President shall use his existing authority to carry out this policy."

5 U.S.C. 7201(c) requires under regulations prescribed by the Office of Personnel Management:

(1) that each Executive agency conduct a continuing program for the recruitment of members of minorities for positions in the agency to carry out the [anti-discrimination] policy set forth in subsection (b) in a manner designed to eliminate underrepresentation of minorities in the various categories of civil service employment within the Federal service, with special efforts directed at recruiting in minority communities, in educational institutions, and from other sources from which minorities can be recruited; and

(2) that the Office conduct a continuing program of—

(A) assistance to agencies in carrying out programs under paragraph (1) of this subsection; and

(B) evaluation and oversight of such recruitment programs to determine their effectiveness in eliminating such minority underrepresentation.

This subpart is consistent with title VII of the Civil Rights Act of 1964, as amended, 42 U.S.C. 2000 *et seq.*

### Subpart B—Special Recruitment Program

#### § 720.201 Regulatory requirements.

This subpart contains the regulations of the Office of Personnel Management which implement the above provisions of title 5, United States Code, and are prescribed by the Office under authority of 5 U.S.C. 7201.

#### § 720.202 Definitions.

For the purposes of this subpart:

(a) "underrepresentation" means a situation in which the number of women or members of a minority group within a category of civil service employment constitutes a lower percentage of the total number of employees within the employment category than the percentage women or the minority constitutes within the civilian labor force of the United States.

(b) "Category of civil service employment" means such groupings of Federal jobs by grades, pay systems and/or occupations as the Office or Personnel Mangagment deems appropriate.

(c) "Minority" refers only to those groups classified as "minority" for the purpose of data collection by the Office of Personnel Management and the Equal Employment Opportunity Commission in furtherance of Federal equal employment opportunity policies. Women include majority as well as minority women.

(d) "Civilian labor force" (CLF) includes all persons 16 years of age and over, except those in the armed forces, who are employed or who are unemployed and seeking work. CLF data are defined by the Bureau of the Census and the Bureau of Labor Statistics and are reported in the most recent decennial or mid-decade census, or current population survey, under Title 13 of the United States Code or other recognized government-conducted survey.

(e) "Recruitment" means the total process by which the Federal government and the Federal agencies locate, identify and assist in the employment or qualified or qualifiable applicants from underrepresented groups for job openings in categories of employment where underrepresentation has been determined and includes both internal placement and external recruitment actions.

(f) "Applicant pool" means all types of listings from which selections may be made, including (but not limited to) promotion lists, competitive certificates and inventories of eligibles, applicant supply files, and lists of eligibles for certain noncompetitive appointments.

**§ 720.203 Responsibilities of the Office of Personnel Management.**

(a) The Office of Personnel Management will provide appropriate data to assist Federal agencies in making determinations of underrepresentation. The process for making such determinations is described in the Appendix to this Part. The Office will develop and publish more specific criteria for statistical measurements to be used by individual agencies, and will develop further guidance on—

(1) agency employment statistics and civilian labor force statistics to be used is making determinations of underrepresentation, on a national, regional or other geographical basis as appropriate;

(2) the nature, size and location of agency components for which determinations and recruitment programs shall be developed;

(3) groupings of grades and/or other occupational categories to be used in implementing agency programs; and

(4) other factors which may be considered by the agency, in consultation with Office of Personnel Management, to make determinations of underrepresentation and to develop recruitment programs focused on specific occupational categories.

(b) The Office will assist agencies in carrying out their programs by—

(1) identifying major recruitment sources of women and members of minority groups and providing guidance on internal placement and external recruitment activities directed toward the solution of specific underrepresentation problems;

(2) identifying occupational categories and job series for which expanded *External* recruitment efforts are most appropriate, and those for which expanded and innovative *internal* recruitment is appropriate;

(3) supplementing agency recruitment efforts, utilizing existing network for dissemination of job information, and arranging the participation of minority group and women's organizations where practicable; and

(4) providing such other support, on agency request, as the Office deems appropriate.

(c) The Office will monitor and, in conjunction with the personnel management evaluation program of the Office, evaluate agency programs to determine their effectiveness in eliminating underrepresentation;

(d) The Office will conduct a continuing program of guidance and instruction to supplement these regulations.

(e) The Office will coordinate further activities to implement special recruitment programs under this subpart with the Equal Employment Opportunity Commission consistent with law, Executive Order 12067, and Reorganization Plan No. 1 of 1978.

**§ 720.204 Agency programs.**

(a) Each Executive agency, as defined in 5 U.S.C. 105, must conduct a continuing program for the recruitment of minorities and women for positions in the agency to carry out the policy of the United States to insure equal employment opportunities without discrimination because of race, color, religion, sex or national origin.

(b) Programs established under this subpart must be designed to cover recruitment for all positions, including part-time and temporary positions, in any category of civil service employment in the competitive, excepted, or Senior Executive Service where underrepresentation has been determined in the agency. On a determination by the Office of Personnel Management that additional component plans are needed to implement an agency's program effectively, the Office will instruct the agency to develop additional plans. Agencies must comply with such instructions.

(c) To the extent possible, agencies must determine whether the applicant pools used in filling jobs in a category of employment where underrepresentation exists include sufficient candidates from groups underrepresented in such category. Where an applicant pool does not include sufficient numbers of members of underrepresented groups, agencies must consider:

(1) Expansion or other redirection of their recruitment activitiies in ways designed to increase the number of candidates from underrepresented groups in that applicant pool;

(2) Use of selection methods involving other applicant pools which include sufficient numbers of underrepresented groups;

(3) Notifying and consulting with the office responsible for administering that applicant pool, and requesting its consideration of reopening application receipt in support of expanded recruitment activities; and

(4) Taking such other action which will contribute to the elimination of underrepresentation in the category of employment involved.

(d) Agencies must notify and seek advice and assistance from the Office of Personnel Management in cases where their special recruitment programs are not making measurable progress in eliminating identified underrepresentation in the agency work force.

**§ 720.205 Agency plans.**

(a) Each agency must have an up-to-date special recruitment program plan covering recruitment for positions at various organizational levels and geographic locations within the agency. Such plans must be available for review in appropriate offices of the agency and must be submitted to the Office of Personnel management on request. Such plans may be incorporated in the agency's equal employment opportunity plans required under section 717 of the Civil Rights Act of 1964, as amended, pursuant to regulations and instructions of the Equal Employment Opportunity Commission, provided they are separable parts of those plans for purposes of review by and submission to the Office of Personnel Management.

(b) Agency plans must include annual specific determinations of underrepresentation and must be accompanied by quantifiable indices by which progress toward eliminating underrepresentation can be measured.

(c) Where an agency or agency component is located in a geographical area where the percentage of underrepresented groups in the area civilian labor force is higher than their percentage in the national labor force, the agency or component must base its plans on the higher level of representation in the relevant civilian labor force.

(d) Where an agency or agency component is located in a geographical area where participation of a particular underrepresented group is significantly lower than its participation in the national labor force, the agency or component may, in consultation with the Office of Personnel Management, use the lower percentage in determining underrepresentation. An agency may not use a figure lower than the relevant regional or nationwide labor force percentage where recruitment on a regional or nationwide basis is feasible for particular categories of employment. Factors such as size of the agency or unit, nature of jobs and their wage or pay scale may be considered in focusing recruitment for various job categories.

(e) In addition to the underrepresentation determinations described in paragraphs (b), (c) and (d) of this section, agency plans must, at a minimum, include an assessment of:

(1) The number of jobs in each category to be filled in each of the next two years;

(2) The numbers estimated to be filled through;

(a) Internal recruitment only; and

(b) External recruitment or a combination of internal and external recruitment;

(3) Recruitment methods to be used;

(4) The size of the internal pool available to fill jobs with careful attention to currently underutilized personnel;

(5) Training and job development programs used to prepare employees for these job catergories;

(6) Jobs which should be redesigned to improve opportunities for minorities and women including jobs requiring bilingual or bicultural capabilities or not requiring English fluency;

(7) Priorities;

(8) Help needed from OPM.

(f) Special recruitment program plans must be consistent with agency Upward Mobility program plans and should be developed with full consideration of the agency's overall recruiting and staffing planning objectives.

(g) Plans required under this subpart must be developed for the headquarters level of each Executive agency not later than July 1, 1979. Plans must be developed for other agency components not later than October 1, 1979.

**§ 720.206 Selection guidelines.**

All selection processes must be consistent with the *Uniform Guidelines on Employee Selection Procedures* (43 FR 38290; August 25, 1978) and the instructions of the Office of Personnel Management on implementing those Guidelines.

**§ 720.207 Reports.**

Not later than November 1 of each year, agencies must submit an annual report on their special recruitment programs to the Office of Personnel Management, in a form prescribed by the Office. The Office may require submission of any additional reports it considers necessary in carrying out its responsibilities under this subpart.

APPENDIX

Guidelines for the Development of a Federal Recruitment Program to Implement 5 U.S.C. Section 7201, as amended [1]

I. *Background Information*

A. In 1964 the Congress adopted a basic anti-discrimination policy for Federal employment, stating:

"It is the policy of the United States to insure equal employment opportunities for employees without discrimination because of race, color, religion, sex or national origin." [5 U.S.C. 7151] [2]

In 1978, Congress reaffirmed and amended this policy as part of the Civil Service Reform Act of 1978 [Sec. 310 of P.L. 95-454], requiring immediate development of a recruitment program designed to eliminate underrepresentation of minority groups in specific Federal job categories. Section 310 directs the Equal Employment Opportunity Commission:

1. to establish Guidelines proposed to be used for a program designed to eliminate such underrepresentation;

2. to make, in consultation with OPM, initial determinations of underrepresentation which are proposed to be used in this program; and

3. to transmit the determinations made under (2) above to the Executive Agencies, the Office of Personnel Management and the Congress, within 60 days of enactment.

The Office of Personnel Management (OPM) [3] is directed by this amendment:

1. to issue regulations to implement a program under EEOC Guidelines within 180 days after enactment, which shall provide that Executive agencies conduct continuing recruitment programs to carry out the anti-discrimination policy in a manner designed to eliminate underrepresentation in identified categories of civil service;

2. to provide continuing assistance to Federal agencies in carrying out such programs;

3. to conduct a continuing program of evaluation and oversight to determine the effectiveness of such programs;

4. to establish occupational, professional and other groupings within which appropriate recruitment will occur, based upon the determinations of underrepresentation pursuant to these Guidelines; and

5. to report annually to the Congress on this programs; not later than January 31 of each year.

Congress further directed that the recruitment program must be administered consistent with provisions of Reorganization Plan No. 1 of 1978.[4]

B. In framing these Guidelines and making its initial determinations of underrepresentation, the Equal Employment Opportunity Commission (Commission) is acting pursuant to its obligations and authority under 5 U.S.C. 7201, as amended; Section 717 of Title VII of the Civil Rights Act of 1964, as amended; Reorganization Plan No. 1 of 1978 (issued pursuant to 5 U.S.C. 901 et seq.) and Executive Order 12067, issued under this Plan (43 FR 28967, June 30, 1978). This Commission must develop and/or ensure the development of uniform, coherent and effective standards for administration and enforcement of all Federal anti-discrimination and equal employment opportunity laws, policies and programs, and to ensure the elimination of duplication and inconsistency in such programs.

C. A review of the legislative history of Federal equal employment opportunity policy provides further guidance on the scope and nature of determinations and guidelines to be issued for this program.

The basic policy statement on Federal equal employment policy enacted by the Congress in 1964 (5 U.S.C. § 7151, redesignated as § 7201) gave the President authority for implementation.

Executive Order 11246 (1966), expanded and superseded by Executive Order 11478 (1969) with respect to Federal employment, required Federal agencies to develop affirmative action programs designed to eliminate discrimination and assure equal employment opportunity.

In 1972, Congress found that serious discrimination persisted in Federal employment. It found that minorities and women were significantly absent at higher levels in Federal employment, and severely underrep- resented in some Federal agencies and in some geographic areas where they constituted significant proportions of the population. After a detailed review of Federal employment practices and statistics, the Congress concluded that:

"the disproportionate distribution of minorities and women throughout the Federal bureaucracy and their exclusion from higher level policy-making and supervisory positions indicates the government's failure to pursue its policy of equal employment opportunity".[5]

Congress found that this exclusion resulted from overt and "systemic" discriminatory practices.

These findings, among others, led Congress to extend Title VII coverage to Federal employment in Section 717 of the Equal Employment Opportunity Act of 1972.

The Civil Service Reform Act of 1978 clearly states, for the first time, that "it is the policy of the United States . . . to provide . . . a Federal workforce reflective of the Nation's diversity. . . ." [6] The Act establishes in law as the first merit principle that recruitment should be designed to achieve a Federal workforce from "all segments of society." Among the personnel practices prohibited by the Act is discrimination prohibited under Title VII of the Civil Rights Act of 1964, as amended.[7] Therefore, the Civil Service Reform Act and its directive for a special recruitment program clearly unite requirements for basic Federal personnel policy with requirements for Federal equal employment policy.

It is clear from the legislative history of Federal equal employment policy that the legal standards of Title VII must be applied to Federal employment. Thus, guidelines for a recruitment program designed to eliminate underrepresentation in Federal agency employment must be developed consistent with the framework of affirmative action programs.

D. Guided by the review of the legislative history, and the responsibilities and authorities cited in I(B) above, the Commission is issuing these Guidelines to provide a framework for development of recruitment program regulations by OPM. The Commission may later provide more detailed guidance, through consultation with OPM, designed to achieve an overall Federal equal employment program which is consistent with, and which effectively implements Title VII requirements.

II. *Initial Determinations of Underrepresentation*

A. Pursuant to Section 7201, underrepresentation exists when the percentages of minority and female Federal employees in specific grades are less than their percentages in the civilian labor force. "Minority" refers only to those groups classified as "minority" for the purpose of data collection by the Commission and OPM in furtherance of Federal equal employment opportunity policies. The civilian labor force includes all persons 16 years of age and over except the armed forces, who are employed or seeking employment. Such a determination of un-

---

[1] This Section originally was Section 701(b) (2nd Proviso) of the Civil Rights Act of 1964 (P.L. 88-352, July 2, 1964), codified as 5 U.S.C. § 7151. Section 7151 was further amended by Section 310 of the Civil Service Reform Act of 1978. This Act also redesignated Section 7151 as Section 7201, effective January 11, 1979. [Sec. 703(a)(1) of the Act.]

[2] *Ibid.*

[3] This Office was created by Reorganization Plan No. 2, issued pursuant to 5 USC 901 *et seq.* It will assume personnel management functions of the present U.S. Civil Service Commission on January 1, 1979.

[4] *Conference Report on Civil Service Reform Act of 1978*, No. 95-1272, p. 145.

[5] *Legislative History of the Equal Employment Opportunity Act of 1972*, p. 83. See pp. 82-86 and 421-425 for Congressional Findings.

[6] Civil Service Reform Act of 1978, Section 3.

[7] Section 101(a) of the Act, 5 USC 2301(b)(1) and 2302(b)(1)(A), as amended.

derrepresentation is designated in these Guidelines as "below the Section 7201 level".

B. The Commission has examined existing data on Federal employment and the civilian labor force and has made initial determinations of underrepresentation of groups by race, national origin and sex in specific grades of the major Federal pay systems, under the legal authorities cited in I(B), above.

C. The Table which follows shows the grades at which the percentage of each group in the Federal workforce falls below its percentage in the civilian labor force. The table covers four major Federal pay systems which account for more than 95 percent of Federal employees, including the Postal Service.[*]

| Sex/Race/ National Origin | Percent of Civilian Labor Force | Grades Below the 7201 Level | | | |
|---|---|---|---|---|---|
| | | Gen Sched and Equivalent | Non-spvsry Regular Wage | Leader Regular Wage | Spvsry Regular Wage |
| Number of Grades | -- | 18 | 15 | 15 | 19 |
| Women | 41.0 | 9+ | 2+ | 2+ | All |
| White | 34.0 | 9+ | All | All | All |
| Black | 4.6 | 11+ | 5+ | 5+ | 5+ |
| Hispanic | 1.7 | 6+ | All | 2,4+ | All |
| AsAm/PacIs | .6 | 1,10+ | 2+ | 2+ | All |
| AmIn/AlNa | .1 | 13+ | 9+ | 1,5,6,9+ | 4,9,11+ |
| Minority Men | 8.9 | 3+ | 13+ | 11,14+ | 13+ |
| Black | 5.3 | 4,6+ | 12+ | 11+ | 11+ |
| Hispanic | 2.8 | All | 14+ | 1,15 | 13-15,17+ |
| AsAm/PacIs | .7 | 1-8,10,16+ | 9,14+ | 1,3,8,9,12+ | 1,3,8,9,17+ |
| AmIn/AlNa | .2 | None | 14 | 1,13+ | 17+ |

NOTES.—1. Comparable data for white men shown below are for reference. White Men ——50.1 ——1-8 ——1-4 ——1-5 ——1-3

2. +means "and all grades above".

3. Detail may not add to total because of rounding.

SOURCES: Civilian Labor Force information based on data from the Current Population Survey, Bureau of Labor Statistics, *Employment and earnings*, Vol. 25, No. 1, January 1978.

Information on grades below 7201 level based on Civil Service Commission data from *Equal Opportunity Statistics*, November 20, 1977 (publication in process).

D. The initial determinations of underrepresentation were based upon average 1977 labor force data from the Current Population Survey published by the Bureau of Labor Statistics (*Employment and Earnings*, January 1978), and 1977 Federal workforce statistics from *Equal Employment Opportunity Statistics* (publication in process).

The labor force figures are published annually; the Federal employment statistics semiannually. These measures, and any modifications agreed upon by the Commission and OPM, will be updated annually.

Regional and area Federal employment statistics are available from the Civil Service Commission (as of January, 1979 the OPM). The latest reliable local labor force data by race, national origin, and sex is from the 1970 Census. The Commission and OPM will consult on appropriate labor force measures to be used for local analyses.

[*]The initial determinations are based on data for only those agencies covered by the Civil Service Reform Act of 1978. The Commission will make subsequent determinations on other agencies covered by Title VII, e.g. the U.S. Postal Service, TVA, Central Intelligence Agency, Federal Reserve Board.

E. These initial determinations are based upon a preliminary analysis of the data, and may be further refined by the Commission, in consultation with OPM, to include geographic and occupational underrepresentation. It is further recognized that for the purpose of developing regulations, the OPM, in consultation with the Commission, will undertake more specific analyses of data use and applicability necessary to develop programs for the Federal agencies pursuant to Section 7201(a)(2)(C). The OPM may establish criteria for grouping agencies, for treating agency components separately and for grouping grades and pay systems. In addition, OPM may study other available data sources and use other techniques to assure statistically significant findings of underrepresentation. Based upon these studies, OPM may make recommendations to the Commission for future determinations of underrepresentation.

III. *Procedures for Developing Recruitment Programs*

A. The program developed and implemented on OPM under Section 7201 should be designed to result in applicant pools with sufficient qualified members of underrepresented groups. Where the supply of such groups initially appears to be low for specific occupational, professional and other groupings, the program should be designed so that recruitment efforts stimulate interest of underrepresented groups in those occupations where there are realistic projections of Federal employment opportunities.

B. In establishing groupings for determining underrepresentation, OPM should utilize broad occupational categories to the extent possible.

C. The Commission recognizes that OPM's regulations should allow flexibility in development and design of each Federal agency's recruitment program. However, all statistical comparisons must be computed in a manner consistent with the method utilized in II C.

The Commission recommends that each agency program meet several minimum requirements. The program should be based on a determination of underrepresentation in the agency's total workforce, in appropriate geographic components; by grade; by broad occupational, professional and other groupings in comparison to the national civilian labor force, according to the criteria developed by OPM under these guidelines.

Where an agency or major component thereof (such as Headquarters and Regional Offices) is located in a geographic area where the percentage of underrepresented groups in the area civilian labor force is *higher* than their percentage in the national labor force, the agency or appropriate component should conduct its recruitment program for that component on the basis of the higher level of representation in the relevant civilian labor force.

Where an agency or major component thereof is located in a geographic area where participation of a particular underrepresented group in the area labor force is significantly *lower* than their participation in the national labor force, such agency or component may, in consultation with OPM, utilize the lower applicable civilian labor force percentage in determining underrepresentation for the component. In no event, however, may the agency utilize a figure lower than the regional or nationwide Section 7201 level for positions where recruitment on a regional or nationwide basis is feasible. Factors such as size of the ageny or unit, nature of jobs and their wage or pay scale may be considered to set goals and to justify a recruitment program focused on various job categories.

IV. Scope of Actions Covered by This Program

A. "Recruitment" under this program is defined as the total process by which the Federal government and the Federal agencies locate, identify and assist in the employment of qualified or qualifiable applicants from underrepresented groups for job openings in grades and in occupational categories where underrepresentation has been determined. This process should include innovative internal, as well as targeted external, recruitment actions.

B. Prior to developing regulations, the Office should review data on personnel actions and other information, to identify those job categories for which internal recruitment and external recruitment is most appropriate and feasible, and to provide guidance to the Federal agencies for targeting their recruitment programs, based on this information. OPM should advise all agencies that all job qualifications, personnel procedures and criteria must be consistent with the *Uniform Guidelines on Employee Selection Procedures* (43 FR 38,290 August 25, 1978) OPM should consider the following in providing guidance to agencies:

1. *External Recruitment Programs*

a. Such programs should focus on grade levels and/or job categories where underrepresentation has been identified and where

external recruitment realistically will result in hiring opportunities.

Recruitment programs also should include a review of job functions to determine those jobs that may be better performed by persons who are bicultural and who have bilingual capabilities, and those jobs that can be performed by persons not fluent in English.

b. Where eligibility lists are used for filling jobs, it is recommended that the regulations require, an analysis by race, national origin and sex, to determine whether the list contains sufficient candidates from groups underrepresented in those jobs. OPM should require that where the list does not have such representation, expanded recruitment procedures be designed to assure that members of underrepresented groups qualified to perform the job(s) are included in the pool of applicants from which the selecting official makes the selection. Such expanded recruitment procedures may include additional external recruitment or various actions (such as described in 2. below) to reach members of these groups within the Federal workforce who are qualified or qualifiable for these jobs.

2. *Internal Recruitment Programs*

a. Internal recruitment programs should be designed by agencies to identify currently qualified or qualifiable persons for job categories and series where underrepresention prevails, according to the national determinations and the determinations made by each agency under these guidelines.

b. Further, OPM should work with Federal agencies to develop effective mechanisms for providing information on Federal job opportunities, targeted to reach Federal employees from underrepresented groups in all agencies in order to broaden the applicant pool.

V. *Consistency with Reorganization Plan No. 1 of 1978*

A. The Office shall develop regulations and implement this program in consultation with the Commission and with other affected agencies in such manner that their recruitment programs may be incorporated as a consistent and effective element of the agencies' national and regional equal employment opportunity plans. Each agency is required to implement such plans under the direction and guidance of the Commission in accordance with Section 717 of Title VII of the Civil Rights Act of 1964, as amended, and Executive Order 12067.

B. Procedures shall be established by OPM and the Commission to assure appropriate consultation in development of the regulations.

C. Pursuant to Reorganization Plan No. 1 and to Executive Order 12067 issued thereunder, the Commission will establish procedures to provide appropriate consultation and review of the program on a continuing basis, to maximize its effectiveness and eliminate any duplication, conflict or inconsistency in requirements for equal opportunity programs in the Federal agencies.

D. In preparing its annual report to the Congress pursuant to the Act, OPM should do so in consultation with the Commission.

NOTE.—Although the Equal Employment Opportunity Commission (EEOC) and the Office of Personnel Management (OPM) have consulted during the drafting of these proposed OPM regulations for a Federal Recruitment Program, as required by 5 U.S.C. 7201 and E.O. 12067, EEOC has not approved these regulations. The EEOC has further changes to propose, and the Commission will not consider these regulations for formal approval until comments from the public and other Federal agencies have been examined.

[FR Doc. 79-4462 Filed 2-8-79; 8:45 am]

Vol. 44—No. 29
2-9-79
BOOK 2:
PAGES
8575-8858

federal register

BOOK 2 OF 2 BOOKS

FRIDAY, FEBRUARY 9, 1979

PART VII

# DEPARTMENT OF LABOR

## Occupational Safety and Health Administration

■

## 29 CFR PART 1926

Safety and Health Regulations for Construction with

## 29 CFR PART 1910

General Industry Safety and Health Regulations Identified as Applicable to Construction

[4510-26-M]

Title 29—Labor

CHAPTER XVII—OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION, DEPARTMENT OF LABOR

PART 1926—OCCUPATIONAL SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION

PART 1910—OCCUPATIONAL SAFETY AND HEALTH STANDARDS

## Identification of General Industry Safety and Health Standards (29 CFR Part 1910) Applicable to Construction Work

AGENCY: Occupational Safety and Health Administration (OSHA).

ACTION: Notice of Enforcement Policy and Republication of Standards.

SUMMARY: To provide a better public understanding and awareness of OSHA's enforcement policy regarding hazards in construction, the agency is reprinting in the FEDERAL REGISTER the entire text of 29 CFR Part 1926 (Safety and Health Regulations for Construction) together with certain General Industry Occupational Safety and Health Standards (29 CFR Part 1910) which have been identified as also applicable to construction work.

For some time, elements of both labor and management within the construction industry have petitioned the agency to develop a single set of OSHA regulations for the exclusive use of that industry. In response to the concerns of the affected parties and the need for a uniform enforcement policy within the agency, OSHA prepared this document with the advice of the Advisory Committee on Construction Safety and Health.

FOR FURTHER INFORMATION CONTACT:
Donald A. Shay, Director, Office of Compliance Programming, U.S. Department of Labor, OSHA, 200 Constitution Avenue NW., Room N3608, Washington, D.C. 20210, telephone: 202-523-8041.

SUPPLEMENTARY INFORMATION: The identification of general industry standards applicable to construction represents the first step in the agency's long range program to modify 29 CFR Part 1926 into a single comprehensive set of OSHA regulations for use on construction worksites. This document should not be construed as representing a permanent recodification since permanent recodification or so-called "verticalization" will be achieved in conjunction with the ongoing comprehensive revisions of the various subparts of part 1926.

To facilitate uniform enforcement, OSHA has issued Program Directive No. 200-88, Identification of General Industry Safety and Health Standards (29 CFR Part 1910) Applicable to Construction Work, outlining the agency's policy to its field personnel. This Program Directive will be made available to the public, and may be obtained from any OSHA Area or Regional Office, or by writing directly to the Office of Field Coordination, Occupational Safety and Health Administration, 3d and Constitution Avenue, Washington, D.C. 20210.

While every effort has been made to identify those part 1910 standards (General Industry) which are most likely to be applicable to construction work, it is to be recognized that there may be others which, under some circumstances, also may be applicable. A special procedure has been established by the National Office to review such situations should they occur.

If enforcement experience indicates that other part 1910 standards are applicable to construction but which have not been previously identified, the listing of such standards will be modified accordingly.

Therefore, in the public interest, OSHA is publishing the following:

Part 1926/1910 Construction Standards. An index and text of selected General Industry Safety and Health Standards (29 CFR Part 1910) identified as applicable to construction work placed with the text of relevant provisions of 29 CFR Part 1926 (Safety and Health Regulations for Construction); this includes all health standards from subpart Z of part 1910 except for the exposure limits contained in Tables Z-1, Z-2, and Z-3 of 29 CFR 1910.1000.

Supplement I. The text of other OSHA standards incorporated by reference in those part 1910 standards identified as applicable to construction work.

Supplement II. A table of "Threshold Limit Values of Airborne Contaminants for 1970" referenced in 29 CFR 1926.55(a) with administrative changes in footnotes and modifications to reflect subsequent OSHA rulemakings (health standards) issued pursuant to section 6(b) of the Act.

Supplement III. A list of standards (other Federal agencies, ANSI, NEC, NFPA, etc.) incorporated by reference in part 1926 and in those part 1910 standards identified as applicable to construction work.

Supplement IV. List of addresses and telephone numbers (where appropriate) of Federal agencies, private organizations, and other sources of standards referenced in OSHA standards applicable to construction work.

Signed this 17th day of October 1978, in Washington, D.C.

EULA BINGHAM,
*Assistant Secretary of Labor.*

## PART 1926—SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION [1]

### Subpart A—General

1926.1 Purpose and scope.
1926.2 Variances from safety and health standards.
1926.3 Inspections—right of entry.
1926.4 Rules of practice for administrative adjudications for enforcement of safety and health standards.

### Subpart B—General Interpretations [1]

1926.10 Scope of subpart.
1926.11 Coverage under section 103 of the act distinguished.
1926.12 Reorganization Plan No. 14 of 1950.
1926.13 Interpretations of statutory terms.
1926.14 Federal contracts for "mixed" types of performance.
1926.15 Relationship to the Service Contract Act; Walsh-Healey Public Contracts Act.
1926.16 Rules of construction.
*1910.11 Scope and purpose.*
*1910.12 Construction work.*
*1910.16 Longshoring.*
*1910.19 Special provisions for air contaminants.*

### Subpart C—General Safety and Health Provisions [1]

1926.20 General safety and health provisions.
1926.21 Safety training and education.
1926.22 Recording and reporting of injuries. [Reserved]
1926.23 First aid and medical attention.
1926.24 Fire protection and prevention.
1926.25 Housekeeping.
1926.26 Illumination.

[1] Portions of the listed part 1910 standards have been identified as applicable to construction.

1926.27 Sanitation.
1926.28 Personal protective equipment.
*1910.132 General requirements (personal protective equipment).*
*1910.136 Occupational foot protection.*
1926.29 Acceptable certifications.
1926.30 Shipbuilding and ship repairing.
1926.31 Incorporation by reference.
1926.32 Definitions.

**Subpart D—Occupational Health and Environmental Controls [1]**

1926.50 Medical services and first aid.
1926.51 Sanitation.
*1910.141 Sanitation.*
*1910.151 Medical services and first aid.*
1926.52 Occupational noise exposure.
1926.53 Ionizing radiation.
1926.54 Nonionizing radiation.
1926.55 Gases, vapors, fumes, dusts, and mists.
*1910.161 Carbon dioxide extinguishing systems.*
1926.56 Illumination.
1926.57 Ventilation.

**Subpart E—Personal Protective and Life Saving Equipment [1]**

1926.100 Head protection.
1926.101 Hearing protection.
1926.102 Eye and face protection.
1926.103 Respiratory protection.
*1910.94 Ventilation.*
*1910.134 Respiratory protection.*
1926.104 Safety belts, lifelines, and lanyards.
1926.105 Safety nets.
1926.106 Working over or near water.
1926.107 Definitions applicable to this subpart.

**Subpart F—Fire Protection and Prevention [1]**

1926.150 Fire protection.
1926.151 Fire prevention.
1926.152 Flammable and combustible liquids.
*1910.106 Flammable and combustible liquids.*
1926.153 Liquefied petroleum gas (LP-Gas).
*1910.110 Storage and handling of liquefied petroleum gases.*
1926.154 Temporary heating devices.
1926.155 Definitions applicable to this subpart.

**Subpart G—Signs, Signals, and Barricades**

1926.200 Accident prevention signs and tags.
1926.201 Signaling.
1926.202 Barricades.
1926.203 Definitions applicable to this subpart.

**Subpart H—Materials Handling, Storage, Use, and Disposal [1]**

1926.250 General requirements for storage.
*1910.30 Other working surfaces.*
*1910.176 Handling materials—general.*
1926.251 Rigging equipment for material handling.
*1910.184 Slings.*
1926.252 Disposal of waste materials.

**Subpart I—Tools—Hand and Power [1]**

1926.300 General requirements.
*1910.212 General requirements for all machines.*
1926.301 Hand tools.
1926.302 Power operated hand tools.
*1910.244 Other portable tools and equipment (abrasive blast cleaning nozzles).*
1926.303 Abrasive wheels and tools.
1926.304 Woodworking tools.
1926.305 Jacks—lever and ratchet, screw and hydraulic.
*1910.244 Other portable tools and equipment (jacks).*

**Subpart J—Welding and Cutting**

1926.350 Gas welding and cutting.
1926.351 Arc welding and cutting.
1926.352 Fire prevention.
1926.353 Ventilation and protection in welding, cutting, and heating.
1926.354 Welding, cutting and heating in way of preservative coatings.

**Subpart K—Electrical**

1926.400 General requirements.
1926.401 Grounding and bonding.
1926.402 Equipment installation and maintenance.
1926.403 Battery rooms and battery charging.
1926.404 Hazardous locations.
1926.405 Definitions applicable to this subpart.

**Subpart L—Ladders and Scaffolding [1]**

1926.450 Ladders.
1926.451 Scaffolding.
*1910.21 Definitions.*
*1910.28 Safety requirements for scaffolding.*
*1910.29 Manually propelled mobile ladder stands and scaffolds (towers).*
1926.452 Definitions applicable to this subpart.

**Subpart M—Floor and Wall Openings and Stairways [1]**

1926.500 Guardrails, handrails, and covers.
*1910.21 Definitions.*
*1910.23 Guarding floor and wall openings and holes.*
1926.501 Stairways.
1926.502 Definitions applicable to this subpart.

**Subpart N—Cranes, Derricks, Hoists, Elevators, and Conveyors**

1926.550 Cranes and derricks.
1926.551 Helicopters.
1926.552 Material hoists, personnel hoists, and elevators.
1926.553 Base-mounted drum hoists.
1926.554 Overhead hoists.
1926.555 Conveyors.
1926.556 Aerial lifts.

**Subpart O—Motor Vehicles, Mechanized Equipment, and Marine Operations [1]**

1926.600 Equipment.
*1910.169 Air receivers.*
*1910.176 Handling materials—general.*
1926.601 Motor vehicles.
1926.602 Material handling equipment.
1926.603 Pile driving equipment.
1926.604 Site clearing.
1926.605 Marine operations and equipment.
1926.606 Definitions applicable to this subpart.

**Subpart P—Excavations, Trenching, and Shoring**

1926.650 General protection requirements.
1926.651 Specific excavation requirements.
1926.652 Specific trenching requirements.
1926.653 Definitions applicable to this subpart.

**Subpart Q—Concrete, Concrete Forms, and Shoring**

1926.700 General provisions.
1926.701 Forms and shoring.
1926.702 Definitions applicable to this subpart.

**Subpart R—Steel Erection**

1926.750 Flooring requirements.
1926.751 Structural steel assembly.
1926.752 Bolting, riveting, fitting-up, and plumbing-up.

**Subpart S—Tunnels and Shafts, Caissons, Cofferdams, and Compressed Air**

1926.800 Tunnels and shafts.
1926.801 Caissons.
1926.802 Cofferdams.
1926.803 Compressed air.
1926.804 Definitions applicable to this subpart.

**Subpart T—Demolition**

1926.850 Preparatory operations.
1926.851 Stairs, passageways, and ladders.
1926.852 Chutes.
1926.853 Removal of materials through floor holes.
1926.854 Removal of walls, masonry sections, and chimneys.
1926.855 Manual removal of floors.
1926.856 Removal of walls, floors, and material with equipment.
1926.857 Storage.
1926.858 Removal of steel construction.
1926.859 Mechanical demolition.
1926.860 Selective demolition by explosives.

**Subpart U—Blasting and use of Explosives [1]**

1926.900 General provisions.
*1910.109 Explosives and blasting agents.*
1926.901 Blaster qualifications.
1926.902 Surface transportation of explosives.
1926.903 Underground transportation of explosives.
1926.904 Storage of explosives and blasting agents.
1926.905 Loading of explosives or blasting agents.
*1910.109 Explosives and blasting agents.*
1926.906 Initiation of explosive charges—electric blasting.
1926.907 Use of safety fuse.
1926.908 Use of detonating cord.
1926.909 Firing the blast.
1926.910 Inspection after blasting.
1926.911 Misfires.
1926.912 Underwater blasting.

[1] Portions of the listed Part 1910 standards have been identified as applicable to construction.

1926.913 Blasting in excavation work under compressed air.
1926.914 Definitions applicable to this subpart.

**Subpart V—Power Transmission and Distribution**

1926.950 General requirements.
1926.951 Tools and protective equipment.
1926.952 Mechanical equipment.
1926.953 Material handling.
1926.954 Grounding for protection of employees.
1926.955 Overhead lines.
1926.956 Underground lines.
1926.957 Construction in energized substations.
1926.958 External load helicopters.
1926.959 Lineman's body belts, safety straps, and lanyards.
1926.960 Definitions applicable to this subpart.

**Subpart W—Rollover Protective Structures; Overhead Protection**

1926.1000 Rollover protective structures (ROPS) for material handling equipment.
1926.1001 Minimum performance criteria for rollover protective structures for designated scrapers, loaders, dozers, graders, and crawler tractors.
1926.1002 Protective frame (ROPS) test procedures and performance requirements for wheel-type agricultural and industrial tractors used in construction.
1926.1003 Overhead protection for operators of agricultural and industrial tractors.

**Subpart X—Effective Dates**

1926.1050 Effective dates (general).
1926.1051 Effective dates (specific).

**Subject Index for Part 1926**

Safety and Health Regulations for Construction.

**Part 1910—Subpart T—Commercial Diving Operations[1]**

*1910.401 Scope and application.*
*1910.402 Definitions.*
*1910.410 Qualifications of dive team.*
*1910.411 Medical requirements.*
*1910.420 Safe practices manual.*
*1910.421 Pre-dive procedures.*
*1910.422 Procedures during dive.*
*1910.423 Post-dive procedures.*
*1910.424 SCUBA diving.*
*1910.425 Surface-supplied air diving.*
*1910.426 Mixed-gas diving.*
*1910.427 Live boating.*
*1910.430 Equipment.*
*1910.440 Recordkeeping requirements.*
*1910.441 Effective date.*

**Part 1910—Subpart Z—Toxic and Hazardous Substances[1]**

*1910.1001 Asbestos.*
*1910.1002 Coal tar pitch volatiles; interpretation of term.*
*1910.1003 4-Nitrobiphenyl.*
*1910.1004 alpha-Naphthylamine.*
*1910.1006 Methyl chloromethyl ether.*
*1910.1007 3,3'-Dichlorobenzidine (and its salts).*
*1910.1008 bis-Chloromethyl ether.*
*1910.1009 beta-Naphthylamine.*
*1910.1010 Benzidine.*
*1910.1011 4-Aminodiphenyl.*
*1910.1012 Ethyleneimine.*
*1910.1013 beta-Propiolactone.*
*1910.1014 2-Acetylaminofluorene.*
*1910.1015 4-Dimethylaminoazobenzene.*
*1910.1016 N-Nitrosodimethylamine.*
*1910.1017 Vinyl chloride.*
*1910.1018 Inorganic arsenic.*
*1910.1028 Benzene.*
*1910.1029 Coke oven emissions.*
*1910.1043 Cotton dust.*
*1910.1044 1,2-Dibromo-3-Chloropropane.*
*1910.1045 Acrylonitrile.*
*1910.1046 Exposure to cotton dust in cotton gins.*

**Supplement I—Text of Other OSHA Standards Incorporated by Reference to Those Part 1910 Standards Identified as Applicable to Construction**

SAFETY STANDARDS

*1910.23(e)(11) Wall opening screens.*
*1910.106(b) Tank storage.*
*1910.106(c) Piping, valves and fittings.*
*1910.110(b) Basic rules (LPG).*

HEALTH STANDARDS

*1910.6 Incorporation by reference.*
*1910.100 Standards organizations.*
*1910.133 Eye and face protection.*
*1910.135 Occupational head protection.*
*1910.136 Occupational foot protection.*
*1910.141(d) (1), (2), (3) Washing facilities.*
*1910.141(e) Change rooms.*
*1910.145(d)(4) Caution signs.*
*1910.184(d) Inspections (slings).*

**Supplement II.—Table of "Threshold Limit Values of Airborne Contaminants for 1970" referenced in 29 CFR 1926.55(a) with administrative changes in footnotes and modifications to reflect subsequent OSHA rulemakings (Health Standards) issued pursuant to section 6(b) of the Act.**

**Supplement III.—List of standards (other Federal agency, ANSI, NEC, NFPA, etc.) incorporated by reference to those part 1910 standards identified as applicable to construction work.**

Private standards—setting organizations.
Federal agencies.
Other governmental agencies.

**Supplement IV.—List of addresses and telephone numbers (where appropriate) of Federal agencies, Private organizations, and other sources of standards referenced in OSHA standards applicable to construction work.**

Addresses of standards organizations referenced.
Addresses of Federal agencies referenced.

AUTHORITY: Secs. 4(b)(2), 6, 8, 84 Stat. 1592, 1593, 1596, 1599 (29 U.S.C. 653, 655, 657); Sec. 107, 83 Stat. 96 (40 U.S.C. 333); Secretary of Labor's Order 8-76 (41 FR 25059); 29 CFR Part 1911;

## PART 1926—SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION

### Subpart A—General

1926.1 Purpose and scope.
1926.2 Variances from safety and health standards.
1926.3 Inspections—right of entry.
1926.4 Rules of practice for administrative adjudications for enforcement of safety and health standards.

**§ 1926.1 Purpose and scope.**

(a) This part sets forth the safety and health standards promulgated by the Secretary of Labor under section 107 of the Contract Work Hours and Safety Standards Act. The standards are published in subpart C of this part and following subparts.

(b) Subpart B of this part contains statements of general policy and interpretations of section 107 of the Contract Work Hours and Safety Standards Act having general applicability.

**§1926.2 Variances from safety and health standards.**

(a) Variances from standards which are, or may be, published in this part may be granted under the same circumstances whereunder variances may be granted under section 6(b)(A) or 6(d) of the Williams-Steiger Occupational Safety and Health Act of 1970 (29 U.S.C. 65). The procedures for the granting of variances and for related relief under this part are those published in part 1905 of this title.

(b) Any requests for variances under this section shall also be considered requests for variances under the Williams-Steiger Occupational Safety and Health Act of 1970, and any requests for variances under Williams-Steiger Occupational Safety and Health Act with respect to construction safety or health standards shall be considered to be also variances under the Construction Safety Act. Any variance from a construction safety or health standard which is contained in this part and which is incorporated by reference in part 1910 of this title shall be deemed a variance from the standard under both the Construction Safety Act and the Williams-Steiger Occupational Safety and Health Act of 1970.

**§ 1926.3 Inspections—Right of entry.**

(a) It shall be a condition of each contract which is subject to section 107 of the Contract Work Hours and Safety Standards Act that the Secretary of Labor or any authorized representative shall have a right of entry to any site of contract performance for the following purposes:

(1) To inspect or investigate the matter of compliance with the safety and health standards contained in sub-

part C of this part and following subparts; and

(2) To carry out the duties of the Secretary under section 107(b) of the Act.

(b) For the purpose of carrying out his investigative duties under the Act, the Secretary of Labor may, by agreement, use with or without reimbursement the services, personnel, and facilities of any State or Federal agency. Any agreements with States under this section shall be similar to those provided for under the Walsh-Healey Public Contracts Act under 41 CFR Part 50-205.

**§1926.4 Rules of practice for administrative adjudications for enforcement of safety and health standards.**

(a) The rules of practice for administrative adjudications for the enforcement of the safety and health standards contained in subpart C of this part and the following subparts shall be the same as those published in part 6 of this title with respect to safety and health violations of the Service Contract Act of 1965 (69 Stat. 1035), except as provided in paragraph (b) of this section.

(b) In the case of debarment, the findings required by section 107(d) of the Act shall be made by the hearing examiner or the Assistant Secretary of Labor for Occupational Safety and Health, as the case may be.

Whenever, as provided in section 107(d)(2), a contractor requests termination of debarment before the end of the 3-year period prescribed in that section, the request shall be filed in writing with the Assistant Secretary of Labor for Occupational Safety and Health who shall publish a notice in the FEDERAL REGISTER that the request has been received and afford interested persons an opportunity to be heard upon the request, and thereafter the provisions of part 6 of this title shall apply with respect to prehearing conferences, hearings, and related matters, and decisions and orders.

**Subpart B—General Interpretations [1]**

1926.10 Scope of subpart.
1926.11 Coverage under section 103 of the act distinguished.
1926.12 Reorganization Plan No. 14 of 1950.
1926.13 Interpretations of statutory terms.
1926.14 Federal contracts for "mixed" types of performance.
1926.15 Relationship to the Service Contract Act; Walsh-Healey Public Contracts Act.
1926.16 Rules of construction.
*1910.11 Scope and purpose.*
*1910.12 Construction work.*
*1910.16 Longshoring.*
*1910.19 Special provisions for air contaminats.*

[1] Portions of the listed part 1910 standards have been identified as applicable to construction.

**§ 1926.10 Scope of subpart.**

(a) This subpart contains the general rules of the Secretary of Labor interpreting and applying the construction safety and health provisions of section 107 of the Contract Work Hours and Safety Standards Act (83 Stat. 96). Section 107 requires as a condition of each contract which is entered into under legislation subject to Reorganization Plan No. 14 of 1950 (64 Stat. 1267), and which is for construction, alteration, and/or repair, including painting and decorating, that no contractor or subcontractor contracting for any part of the contract work shall require any laborer or mechanic employed in the performance of the contract to work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to his health or safety, as determined under construction safety and health standards promulgated by the Secretary by regulation.

**§ 1926.11 Coverage under section 103 of the Act distinguished.**

(a) *Coverage under section 103.* It is important to note that the coverage of section 107 differs from that for the overtime requirements of the Contract Work Hours and Safety Standards Act. The application of the overtime requirements is governed by section 103, which, subject to specific exemptions, includes (1) Federal contracts requiring or involving the employment of laborers or mechanics (thus including, but not limited to, contracts for construction), and (2) contracts assisted in whole or in part by Federal loans, grants, or guarantees under any statute "providing wage standards for such work." The statutes "providing wage standards for such work" include statutes for construction which require the payment of minimum wages in accordance with prevailing wage findings by the Secretary of Labor in accordance with the Davis-Bacon Act. A provision to section 103 excludes from the overtime requirements work where the Federal assistance is only in the form of a loan guarantee or insurance.

(b) *Coverage under section 107.* To be covered by section 107 of the Contract Work Hours and Safety Standards Act, a contract must be one which (1) is entered into under a statute that is subject to Reorganization Plan No. 14 of 1950 (64 Stat. 1247); and (2) is for "construction, alteration, and/or repair, including painting and decorating."

**§ 1926.12 Reorganization Plan No. 14 of 1950.**

(a) *General provisions.* Reorganization Plan No. 14 of 1950 relates to the prescribing by the Secretary of Labor of "appropriate standards, regulations, and procedures" with respect to the enforcement of labor standards under Federal and federally assisted contracts which are subject to various statutes subject to the Plan. The rules of the Secretary of Labor implementing the Plan are published in part 5 of this title. Briefly, the statutes subject to the Plan include the Davis-Bacon Act including its extension to Federal-aid highway legislation subject to 23 U.S.C. 113, and other statutes subject to the Plan by its original terms, statutes by which the Plan is expressly applied, such as the Contract Work Hours and Safety Standards Act by virtue of section 104(d) thereof.

(b) *The Plan.* (1) The statutes subject to Reorganization Plan No. 14 of 1950 are cited and briefly described in the remaining subparagraphs of this paragraph. These descriptions are general in nature and not intended to convey the full scope of the work to be performed under each statute. The individual statutes should be resorted to for a more detailed scope of the work.

(2) *Federal-Aid Highway Acts.* The provisions codified in 23 U.S.C. 113 apply to the initial construction, reconstruction, or improvement work performed by contractors or subcontractors on highway projects on the Federal-aid systems, the primary and secondary, as well as their extensions in urban areas, and the Interstate System, authorized under the highway laws providing for the expenditure of Federal funds upon the Federal-aid system. As cited in 41 Op. A.G. 488, 496, the Attorney General ruled that the Federal-Aid Highway Acts are subject to Reorganization Plan No. 14 of 1950.

(3) *National Housing Act (12 U.S.C. 1713, 1715a, 1715e, 1715k, 1715l(d) (3) and (4), 1715v, 1715w, 1715x, 1743, 1747, 1748, 1748h-2, 1750g, 1715l(h)(1), 1715z(j)(1), 1715z-1, 1715y(d), Subchapter 1x-A and 1 x-B, 1715z-7).* This act covers construction which is financed with assistance by the Federal Government through programs of loan and mortgage insurance for the following purposes:

(i) Rental housing: Section 1713 provides mortgage and insurance on rental housing of eight or more units and on mobile-home courts.

(ii) Section 1715a: Repealed.

(iii) Cooperative housing: Section 1715e authorizes mortgage insurance on cooperative housing of five or more units as well as supplementary loans for improvement of repair or resale of memberships.

(iv) Urban renewal housing: Section 1715k provides mortgage insurance on single family or multifamily housing in approved urban renewal areas.

(v) Low or moderate income housing: Section 1715l(d) (3) and (4) insures

mortgages on low-cost single family or multifamily housing.

(vi) Housing for elderly: Section 1715v provides mortgage insurance on rental housing for elderly or handicapped persons.

(vii) Nursing homes: Section 1715w authorizes mortgage insurance on nursing home facilities and major equipment.

(viii) Experimental housing: Section 1715x provides mortgage insurance on single family or multifamily housing with experimental design of materials.

(ix) War housing insurance: Section 1743 not active.

(x) Yield insurance: Section 1747 insures investment returns on multifamily housing.

(xi) Armed services housing: Section 1748b to assist in relieving acute shortage and urgent need for family housing at or in areas adjacent to military installations.

(xii) Defense housing for impacted areas: Section 1748h-2 provides mortgage insurance on single family or multifamily housing for sale or rent primarily to military or civilian personnel of the Armed Services, National Aeronautics and Space Administration, or Atomic Energy Commission.

(xiii) Defense rental housing: Section 1750g provides for mortgage insurance in critical defense housing areas.

(xiv) Rehabilitation: Section 1715l(h)(1) provides mortgage insurance for nonprofit organizations to finance the purchase and rehabilitation of deteriorating or substandard housing for subsequent resale to low-income home purchasers. There must be located on the property five or more single family dwellings of detached, semidetached, or row construction.

(xv) Homeowner assistance: Section 1715z(j)(1) authorizes mortgage insurance to nonprofit organizations or public bodies or agencies executed to finance sale of individual dwellings to lower income individuals or families. Also includes the rehabilitation of such housing if it is deteriorating or substandard for subsequent resale to lower income home purchasers.

(xvi) Rental housing assistance: Section 1715z-1 authorizes mortgage insurance and interest reduction payments on behalf of owners of rental housing projects designed for occupancy by lower income families. Payments are also authorized for certain State or locally aided projects.

(xvii) Condominium housing: Section 1715y(d) provides mortgage insurance on property purchased for the development of building sites. This includes waterlines and water supply installations, sewer lines and sewage disposal installations, steam, gas, and electrical lines and installations, roads, streets, curbs, gutters, sidewalks, storm drainage facilities, and other installations or work.

(xviii) Group medical practice facilities: Subchapter LX-B authorizes mortgage insurance for the financing of construction and equipment, of facilities for group practice of medicine, optometry, or dentistry.

(xix) Nonprofit hospitals: 1715z-7 authorizes mortgage insurance to cover new and rehabilitated hospitals, including initial equipment.

(4) *Hospital Survey and Construction Act, as amended by the Hospital and Medical Facilities Amendments of 1964 (42 U.S.C. 291e).* The provisions of this Act cover construction contracts made by State or local authorities or private institutions under Federal grant-in-aid programs for the construction of hospitals and other medical facilities.

(5) *Federal Airport Act (49 U.S.C. 1114(b)).* The Act provides grant-in-aid funds for airport construction limited to general site preparation, runways, taxiways, aprons, lighting appurtenant thereto, and fire, rescue, and maintenance buildings. The Act excludes construction intended for use as a public parking facility for passenger automobiles and the cost of construction of any part of an airport building except such of those buildings or parts of buildings to house facilities or activities directly related to the safety of persons at the airport.

(6) *Housing Act of 1949 (42 U.S.C. 1459).* Construction contracts awarded by local authorities financed with the assistance of loans and grants from the Federal Government. The construction programs are for slum clearance and urban renewal which includes rehabilitation grants, neighborhood development programs, neighborhood renewal plans, community renewal, demolition projects, and assistance for blighted areas. See the Housing Act of 1964, No. 21 below, concerning financial assistance for low-rent housing for domestic farm labor.

(7) *School Survey and Construction Act of 1950 (20 U.S.C. 636).* This Act provides for a Federal grant-in-aid program to assist in the construction of schools in federally affected areas.

(8) *Defense Housing and Community Facilities and Services Act of 1951 (42 U.S.C. 1592i).* Inactive Program.

(9) *United States Housing Act of 1937 (42 U.S.C. 1416).* This statute covers the construction of low-rent public housing and slum clearance projects awarded by local authorities. These projects are financed with the assistance of loans and grants from the Federal Government. The slum clearance is the demolition and removal of buildings from any slum area to be used for a low-rent housing project.

(10) *Federal Civil Defense Act of 1950 (50 U.S.C. App. 2281).* This Act provides for Federal assistance to the several States and their political subdivisions in the field of civil defense which includes procurement, construction, leasing, or renovating of materials and facilities.

(11) *Delaware River Basin Compact (sec. 15.1, 75 Stat. 714).* This joint resolution creates, by intergovernmental compact between the United States, Delaware, New Jersey, New York, and Pennsylvania, a regional agency for planning, conservation, utilization, development, management and control of the water and related sources of the Delaware River.

(12) *Cooperative Research Act (20 U.S.C. 332a(c)).* This Act provides Federal grants to a university, college, or other appropriate public or nonprofit private agency or institution for part or all of the cost of constructing a facility for research or for research and related purposes. Research and related purposes means research, research training, surveys, or demonstrations in the field of education, or the dissemination of information derived therefrom, or all of such activities, including (but without limitation) experimental schools, except that such term does not include research, research training, surveys, or demonstrations in the field of sectarian instruction or the dissemination of information derived therefrom. Construction includes new buildings, and the acquisition, expansion, remodeling, replacement, and alteration of existing buildings and the equipping of new buildings and existing buildings.

(13) *Health Professions Educational Assistance Act of 1963 (42 U.S.C. 292d(c)(4), 293a(c)(5)).* The provisions of this Act provide for grants to assist public and nonprofit medical, dental, and similar schools for the construction, expansion, or renovation of teaching facilities.

(14) *Mental Retardation Facilities Construction Act (42 U.S.C. 295(a)(2)(d), 2662(5), 2675(a)(5)).* This Act authorizes Federal financial assistance in the construction of centers for research on mental retardation and related aspects of human development, of university-affiliated facilities for the mentally retarded and of facilities for the mentally retarded.

(15) *Community Mental Health Centers Act (42 U.S.C. 2685(a)(5)).* This Act authorizes Federal grants for the construction of public and other nonprofit community mental health centers.

(16) *Higher Education Facilities Act of 1963 (20 U.S.C. 753).* This Act authorized the grant or loan of Federal funds to assist public and other nonprofit institutions of higher education in financing the construction, rehabili-

tation, or improvement of academic and related facilities in undergraduate and graduate schools.

(17) *Vocational Educational Act of 1963 (20 U.S.C. 35f).* This Act provides for Federal grants to the various States for construction of area vocational educational school facilities.

(18) *Library Services and Construction Act (20 U.S.C. 355e(a)(4)).* This Act provides for Federal assistance to the various States for the construction of public libraries.

(19) *Urban Mass Transportation Act of 1954 (49 U.S.C. 1609).* This Act provides for grants and loans to assist States and local public bodies and agencies thereof in financing the acquisition, construction, reconstruction, and improvement of facilities and equipment for use, by operation or lease or otherwise, in mass transportation service in urban areas and in coordinating such service with highway and other transportation in such areas.

(20) *Economic Opportunity Act of 1964 (42 U.S.C. 2947).* This Act covers construction which is financed with assistance of the Federal Government for the following purposes:

(i) Authorizes Federal assistance for construction of projects, buildings and works which will provide young men and women in rural and urban residential centers with education, vocational training, and useful work experience (title I).

(ii) Authorizes financial assistance for construction work planned and carried out at the community level for antipoverty programs (title II):

(A) Authorizes loans to low income rural families by assisting them to acquire or improve real estate or reduce encumbrances or erect improvements thereon, and to participate in cooperative associations and/or to finance nonagricultural enterprises which will enable such families to supplement their income (title III);

(B) Authorizes loans to local cooperative associations furnishing essential processing, purchasing, or marketing services, supplies, or facilities predominantly to low-income rural families (title III);

(C) Authorizes financial assistance to States, political subdivisions of States, public and nonprofit agencies, institutions, organizations, farm associations, or individuals in establishing housing, sanitation, education, and child day-care programs for migrants and other seasonally employed agricultural employees and their families (title III).

(iii) Authorizes loans or guarantees loans to small businesses for construction work (title IV).

(iv) Authorizes the payment of the cost of experimental, pilot, or demonstration projects to foster State programs providing construction work experience or training for unemployed fathers and needy people (title V).

(21) *Housing Act of 1964 (42 U.S.C. 1486(f); 42 U.S.C. 1452(e)).* Provides financial assistance for low-rent housing for domestic farm labor. The Act further provides for loans, through public or private agencies, where feasible, to owners or tenants of property in urban renewal areas to finance rehabilitation required to conform the property to applicable code requirements or carry out the objectives of the urban renewal plan for the area.

(22) *The Commercial Fisheries Research and Development Act of 1964 (16 U.S.C. 779e(b)).* This Act authorizes financial assistance to State agencies for construction projects designed for the research and development of the commercial fisheries resources of the Nation.

(23) *The Nurse Training Act of 1964 (42 U.S.C. 296a(b)(5)).* This Act provides for grants to assist in the construction of new facilities for collegiate, associate degree, and diploma schools of nursing, or replacement or rehabilitation of existing facilities of such schools.

(24) *Elementary and Secondary Education Act of 1965 (20 U.S.C. 241i, 848).* The purpose of the Act is to provide financial assistance to local educational agencies serving areas with concentrations of children from low-income families for construction in connection with the expansion or improvement of their educational programs.

(25) *Federal Water Pollution Control Act, as amended by the Water Quality Act of 1965 (3 U.S.C. 466e(g)).* Provides for financial assistance to States or municipalities for construction of facilities in connection with the prevention and control of water pollution. This includes projects that will control the discharge into any waters of untreated or inadequately treated sewage.

(26) *Appalachian Regional Development Act of 1965 (40 U.S.C. App. 402).* Authorizes Federal assistance in the construction of an Appalachian development highway system; construction of multicounty demonstration health facilities, hospitals, regional health, diagnostic and treatment centers, and other facilities for health; seal and fill voids in abandoned mines and to rehabilitate strip mine areas; construction of school facilities for vocational education; and to assist in construction of sewage treatment works.

(27) *National Technical Institute for the Deaf Act (20 U.S.C. 684(b)(5)).* Provides for financial assistance for institutions of higher education for the establishment, construction, including equipment and operation, of a National Institution for the Deaf.

(28) *Housing Act of 1959 (12 U.S.C. 1701(q)(c)(3)).* This Act authorizes loans to nonprofit corporations to be used for the construction of housing and related facilities for elderly families. Also, the provisions of the Act provide for rehabilitation, alteration, conversion or improvement of existing structures which are otherwise inadequate for proposed dwellings used by such families.

(29) *College Housing Act of 1950, as amended (12 U.S.C. 1749a(f)).* This Act provides for Federal loans to assist educational institutions in providing housing and other educational facilities for students and faculties.

(30) *Housing and Urban Development Act of 1965 (42 U.S.C. 1500c-3, 3107).* This Act provides for Federal assistance for the following purposes:

(i) Grants to States and local public bodies to assist in any construction work to be carried out under the open-space land and urban beautification provisions contained therein. It provides for parks and recreation areas, conservation of land and other natural resources, and historical and scenic purposes.

(ii) Grants to local public bodies and agencies to finance specific projects for basic public water facilities (including works for the storage, treatment, purification, and distribution of water), and for basic public sewer facilities (other than "treatment works" as defined in the Federal Water Pollution Control Act).

(iii) Grants to any local public body or agency to assist in financing neighborhood facilities. These facilities must be necessary for carrying out a program of health, recreational, social, or similar community service and located so as to be available for the use of the area's low or moderate income residents.

(31) *National Foundation on the Arts and the Humanities Act of 1965 (20 U.S.C. 954(k)).* The Act establishes the "National Foundation on the Arts and the Humanities" which may provide matching grants to groups (nonprofit organizations and State and other public organizations) and to individuals engaged in creative and performing arts for the entire range of artistic activity, including construction of necessary facilities.

(32) *Public Works and Economic Development Act of 1965 (42 U.S.C. 3222).* This Act provides for Federal assistance for the following purposes:

(i) Grants for the acquisition or development of land or improvements for public works or development facility usage in redevelopment areas. It authorizes loans to assist in financing the purchase or development of land for public works which will assist in the creation of long-term employment opportunities in the area.

(ii) Loans for the purchase or development of land and facilities (including machinery and equipment) for industrial or commercial usage within redevelopment areas; guarantee of loans for working capital made to private borrowers by private lending institutions in connection with direct loan projects; and to contract to pay to, or on behalf of, business entities locating in redevelopment areas, a portion of the interest costs which they incur in financing their expansions from private sources.

(iii) Loans and grants to create economic development centers within designated country economic development districts.

(33) *High-Speed Ground Transportation Study (40 U.S.C. 1636(b)).* This Act provides for financial assistance for construction activities in connection with research and development of different forms of high-speed ground transportation and demonstration projects relating to intercity rail passenger service.

(34) *Heart Disease, Cancer and Stroke Amendments of 1965 (42 U.S.C. 299(b)(4)).* This Act provides for grants to public or nonprofit private universities, medical schools, research institutions, hospitals, and other public and nonprofit agencies and institutions, or associations thereof to assist in construction and equipment of facilities in connection with research, training, demonstration of patient care, diagnostic and treatment related to heart disease, cancer, stroke, and other major diseases.

(35) *Mental Retardation Facilities and Community Mental Health Centers Construction Act Amendments of 1965 (20 U.S.C. 613(g)).* These provisions provide for grants to institutions of higher education for construction of facilities for research or for research and related purposes relating to education for mentally retarded, hard of hearing, deaf, speech impaired, visually handicapped, seriously emotionally disturbed, crippled, or other health impaired children who by reason thereof require special education.

(36) *Vocational Rehabilitation Act Amendments of 1965 (29 U.S.C. 41a(b)(4)).* This Act authorizes grants to assist in meeting the costs of construction of public or other nonprofit workshops and rehabilitation facilities.

(37) *Clean Air and Solid Waste Disposal Acts (42 U.S.C. 3256).* This Act provides for financial assistance to public (Federal, State, interstate, or local) authorities, agencies, and institutions, private agencies and institutions, and individuals in the construction of facilities for solid-waste disposal. The term construction includes the installation of initial equipment.

(38) *Medical Library Assistance Act of 1965 (42 U.S.C. 280b-3(b)(3)).* This Act provides for grants to public or private nonprofit agencies or institutions for the cost of construction of medical library facilities.

(39) *Veterans Nursing Home Care Act (38 U.S.C. 5035(a)(8)).* The construction industry health and safety standards do not apply to this Act since it is not subject to Reorganization Plan No. 14 of 1950.

(40) *National Capital Transportation Act of 1965 (40 U.S.C. 682(b)(4)).* This Act provides for Federal assistance to the National Capital Transportation Agency for construction of a rail rapid transit system and related facilities for the Nation's Capital.

(41) *Alaska Centennial—1967 (80 Stat. 82).* The program under this legislation has expired.

(42) *Model Secondary School for the Deaf Act (80 Stat. 1028).* This Act provides for funds to establish and operate, including construction and initial equipment of new buildings, expansion, remodeling, and alteration of existing buildings and equipment thereof, a model secondary school for the deaf to serve the residents of the District of Columbia and nearby States.

(43) *Allied Health Professions Personnel Training Act of 1966 (42 U.S.C. 295h(b)(2)(E)).* This Act provides for grants to assist in the construction of new facilities for training centers for allied health professions, or replacement or rehabilitation of existing facilities for such centers.

(44) *Demonstration Cities and Metropolitan Development Act of 1966 (42 U.S.C. 3310; 12 U.S.C. 1715c; 42 U.S.C. 1416).* This Act provides for Federal assistance for the following purposes:

(i) Grants to assist in the construction, rehabilitation, alteration, or repair of residential property only if such residential property is designed for residential use for eight or more families to enable city demonstration agencies to carry out comprehensive city demonstration programs (42 U.S.C. 3310).

(ii) Amends the National Housing Act (12 U.S.C. 1715c) and the Housing Act of 1937 (42 U.S.C. 1416). See these Acts for coverage.

(45) *Air Quality Act of 1967 (42 U.S.C 1857j-3).* This Act provides for Federal assistance to public or nonprofit agencies, institutions, and organizations and to individuals, and contracts with public or private agencies, institutions, or persons for construction of research and development facilities and demonstration plants relating to the application of preventing or controlling discharges into the air of various types of pollutants.

(46) *Elementary and Secondary Education Amendments of 1967 (Title VII—Bilingual Education Act) (20 U.S.C. 880b-6).* This Act provides for Federal assistance to local educational agencies or to an institution of higher education applying jointly with a local educational agency for minor remodeling projects in connection with bilingual education programs to meet the special needs of children with limited English-speaking ability in the United States.

(47) *Vocational Rehabilitation Amendments of 1967 (29 U.S.C. 42a(c)(3)).* This Act authorizes Federal assistance to any public or nonprofit private agency or organization for the construction of a center for vocational rehabilitation of handicapped individuals who are both deaf and blind which shall be known as the National Center for Deaf-Blind Youths and Adults. Construction includes new buildings and expansion, remodeling, alteration and renovation of existing buildings, and initial equipment of such new, newly acquired, expanded, remodeled, altered, or renovated buildings.

(48) *National Visitor Center Facilities Act of 1968 (40 U.S.C. 808).* This Act authorizes agreements and leases with the owner of property in the District of Columbia known as Union Station for the use of all or a part of such property for a national visitor center to be known as the National Visitor Center. The agreements and leases shall provide for such alterations of the Union Station Building as necessary to provide adequate facilities for visitors. They also provide for the construction of a parking facility, including necessary approaches and ramps.

(49) *Juvenile Delinquency Prevention and Control Act of 1968 (42 U.S.C. 3843).* This Act provides for Federal grants to State, county, municipal, or other public agency or combination thereof for the construction of facilities to be used in connection with rehabilitation services for the diagnosis, treatment, and rehabilitation of delinquent youths and youths in danger of becoming delinquent.

(50) *Housing and Urban Development Act of 1968 (including New Communities Act of 1968) (42 U.S.C. 3909).* This Act provides for Federal assistance for the following purposes:

(i) Guarantees, and commitments to guarantee, the bonds, debentures, notes, and other obligations issued by new community developers to help finance new community development projects.

(ii) Amends section 212(a) of the National Housing Act, adding section 236 for "Rental Housing for Lower Income Families" and section 242 "Mortgage Insurance for Nonprofit Hospitals" thereto.

(51) *Public Health Service Act Amendment (Alcoholic and Narcotic*

*Addict Rehabilitation Amendments of 1968) (42 U.S.C. 2681, et seq.).* This Act provides for grants to a public and nonprofit private agency or organization for construction projects consisting of any facilities (including post-hospitalization treatment facilities for the prevention and treatment of alcoholism or treatment of narcotic addicts).

(52) *Vocational Education Amendments of 1968 (20 U.S.C. 1246).* This Act provides for grants to States for the construction of area vocational education school facilities. The Act further provides grants to public educational agencies, organizations, or institutions for construction of residential schools to provide vocational education for the purpose of demonstrating the feasibility and desirability of such schools. The Act still further provides grants to State boards, to colleges and universities, to public educational agencies, organizations or institutions to reduce the cost of borrowing funds for the construction of residential schools and dormitories.

(53) *Postal Reorganization Act (39 U.S.C. 410(d)(2)).* This Act provides for construction, modification, alteration, repair, and other improvements of postal facilities located in leased buildings.

(54) *Airport and Airway Development Act of 1970 (Pub. L. 91-258, sec. 52(b)(7)).* This Act provides for Federal financial assistance to States and localities for the construction, improvement, or repair of public airports.

(i) *Pub. L. 91-230.* This Act provides for Federal financial assistance to institutions of higher learning for the construction of a National Center on Educational Media and Materials for the Handicapped. The program under this statute expires on July 1, 1971. Pub. L. 91-230, section 662(1).

(ii) *Education of the Handicapped Act (20 U.S.C. 12326, 1404(a)).* This Act provides for financial assistance to States for construction, expansion, remodeling, or alteration of facilities for the education of handicapped children at the preschool, elementary school, and secondary school levels.

(56) *Housing and Urban Development Act of 1970 (Pub. L. 91-609, sec. 707(b)).* This Act provides for grants to States and local public agencies to help finance the development of open-space or other land in urban areas for open-space uses. This Act becomes effective on July 1, 1971.

(57) *Developmental Disabilities Services and Facilities Construction Amendments of 1970 (Pub. L. 91-517, sec. 135(a)(5)).* This Act authorizes grants to States for construction of facilities for the provision of services to persons with developmental disabilities who are unable to pay for such services.

(58) *Rail Passenger Service Act of 1970 (Pub. L. 91-518, sec. 405(d)).* This statute provides that the National Railroad Passenger Corporation may construct physical facilities necessary to intercity rail passenger operations within the basic national rail passenger system designated by the Secretary of Transportation.

(c) *VA and FHA housing.* In the course of the legislative development of section 107, it was recognized that section 107 would not apply to housing construction for which insurance was issued by the Federal Housing Authority and Veterans' Administration for individual home ownership. Concerning construction under the National Housing Act, Reorganization Plan No. 14 of 1950 applies to construction which is subject to the minimum wage requirements of section 212(a) thereof (12 U.S.C. 1715c).

### § 1926.13 Interpretation of statutory terms.

(a) The terms "construction," "alteration," and "repair" used in section 107 of the Act are also used in section 1 of the Davis-Bacon Act (40 U.S.C. 276a), providing minimum wage protection on Federal construction contracts, and section 1 of the Miller Act (40 U.S.C. 270a), providing performance and payment bond protection on Federal construction contracts. Similarly, the terms "contractor" and "subcontractor" are used in those statutes, as well as in Copeland (Anti-Kickback) Act (40 U.S.C. 276c) and the Contract Work Hours and Safety Standards Act itself, which apply concurrently with the Miller Act and the Davis-Bacon Act on Federal construction contracts and also apply to most federally assisted construction contracts. The use of the same or identical terms in these statutes which apply concurrently with section 107 of the Act have considerable precedential value in ascertaining the coverage of section 107.

(b) It should be noted that section 1 of the Davis-Bacon Act limits minimum wage protection to laborers and mechanics "employed directly" upon the "site of the work." There is no comparable limitation in section 107 of the Act. Section 107 expressly requires as a self-executing condition of each covered contract that no contractor or subcontractor shall require "any laborer or mechanic employed in the performance of the contract to work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to his health or safety" as these health and safety standards are applied in the rules of the Secretary of Labor.

(c) The term "subcontractor" under section 107 is considered to mean a person who agrees to perform any part of the labor or material requirements of a contract for construction, alteration or repair. Cf. *MacEvoy Co.* v. *United States,* 322 U.S. 102, 108-9 (1944). A person who undertakes to perform a portion of a contract involving the furnishing of supplies or materials will be considered a "subcontractor" under this part and section 107 if the work in question involves the performance of construction work and is to be performed: (1) Directly on or near the construction site, or (2) by the employer for the specific project on a customized basis. Thus, a supplier of materials which will become an integral part of the construction is a "subcontractor" if the supplier fabricates or assembles the goods or materials in question specifically for the construction project and the work involved may be said to be construction activity. If the goods or materials in question are ordinarily sold to other customers from regular inventory, the supplier is not a "subcontractor." Generally, the furnishing of prestressed concrete beams and prestressed structural steel would be considered manufacturing, therefore a supplier of such materials would not be considered a "subcontractor." An example of material supplied "for the specific project on a customized basis" as that phrase is used in this section would be ventilating ducts, fabricated in a shop away from the construction jobsite and specifically cut for the project according to design specifications. On the other hand, if a contractor buys standard size nails from a foundry, the foundry would not be a covered "subcontractor." Ordinarily a contract for the supplying of construction equipment to a contractor would not, in and of itself, be considered a "subcontractor" for purposes of this part.

### § 1926.14 Federal contract for "mixed" types of performance.

(a) It is the intent of the Congress to provide safety and health protection of Federal, federally financed, or federally assisted construction. See, for example, H. Report No. 91-241, 91st Cong., first session, p. 1 (1969). Thus, it is clear that when a Federal contract calls for mixed types of performance, such as both manufacturing and construction, section 107 would apply to the construction. By its express terms, section 107 applies to a contract which is "for construction, alteration, and/or repair." Such a contract is not required to be exclusively for such services. The application of the section is not limited to contracts which permit an overall characterization as "construction contracts." The text of section 107 is not so limited.

(b) When the mixed types of performances include both construction and manufacturing, see also § 1926.15(b) concerning the relationship between

the Walsh-Healey Public Contracts Act and section 107.

**§ 1926.15 Relationship to the Service Contract Act; Walsh-Healey Public Contracts Act.**

(a) A contract for "construction" is one for nonpersonal service. See e.g., 41 CFR 1-1.298. Section 2(e) of the Service Contract Act of 1965 requires as a condition of every Federal contract (and bid specification therefor) exceeding $2,500, the "principal purpose" of which is to furnish services to the United States through the use of "service employees," that certain safety and health standards be met. See 29 CFR part 1925, which contains the Department rules concerning these standards. Section 7 of the Service Contract Act provides that the Act shall not apply to "any contract of the United States or District of Columbia for construction, alteration, and/or repair, including painting and decorating of public buildings or public works." It is clear from the legislative history of section 107 that no gaps in coverage between the two statutes are intended.

(b) The Walsh-Healey Public Contracts Act requires that contracts entered into by any Federal agency for the manufacture or furnishing of materials, supplies, articles, and equipment in any amount exceeding $10,000 must contain, among other provisions, a requirement that "no part of such contract will be performed nor will any of the materials, supplies, articles or equipment to be manufactured or furnished under said contract be manufactured or fabricated in any plants, factories, buildings, or surroundings or under working conditions which are unsanitary or hazardous or dangerous to the health and safety of employees engaged in the performance of said contract." The rules of the Secretary concerning these standards are published in 41 CFR Part 50-204, and express the Secretary of Labor's interpretation and application of section 1(e) of the Walsh-Healey Public Contracts Act to certain particular working conditions. None of the described working conditions are intended to deal with construction activities, although such activities may conceivably be a part of a contract which is subject to the Walsh-Healey Public Contracts Act. Nevertheless, such activities remain subject to the general statutory duty prescribed by section 1(e). Section 103(b) of the Contract Work Hours and Safety Standards Act provides, among other things, that the Act shall not apply to any work required to be done in accordance with the provisions of the Walsh-Healey Public Contracts Act.

**§ 1926.16 Rules of construction.**

(a) The prime contractor and any subcontractors may make their own arrangements with respect to obligations which might be more appropriately treated on a jobsite basis rather than individually. Thus, for example, the prime contractor and his subcontractors may wish to make an express agreement that the prime contractor or one of the subcontractors will provide all required first-aid or toilet facilities, thus relieving the subcontractors from the actual, but not any legal, responsibility (or, as the case may be, relieving the other subcontractors from this responsibility). In no case shall the prime contractor be relieved of overall responsibility for compliance with the requirements of this part for all work to be performed under the contract.

(b) By contracting for full performance of a contract subject to section 107 of the Act, the prime contractor assumes all obligations prescribed as employer obligations under the standards contained in this part, whether or not he subcontracts any part of the work.

(c) To the extent that a subcontractor of any tier agrees to perform any part of the contract, he also assumes responsibility for complying with the standards in this part with respect to that part. Thus, the prime contractor assumes the entire responsibility under the contract and the subcontractor assumes responsibility with respect to his portion of the work. With respect to subcontracted work, the prime contractor and any subcontractor or subcontractors shall be deemed to have joint responsibility.

(d) Where joint responsibility exists, both the prime contractor and his subcontractor or subcontractors, regardless of tier, shall be considered subject to the enforcement provisions of the Act.

The following requirements from 29 CFR Part 1910 (General Industry) have been identified as applicable to construction (29 CFR 1926 Subpart B), in accordance with their respective scopes and definitions.

**§ 1910.11 Scope and purpose.**

(a) The provisions of this subpart B adopt and extend the applicability of, established Federal standards in effect on April 28, 1971, with respect to every employer, employee, and employment covered by the Act.

(b) It bears emphasis that only standards (i.e., substantive rules) relating to safety or health are adopted by any incorporations by reference of standards prescribed elsewhere in this chapter or this title. Other materials contained in the referenced parties are not adopted. Illustrations of the types of materials which are not adopted are these. The incorporations by reference of parts 1915, 1916, 1917, 1918 in §§ 1910.13, 1910.14, 1910.15, and 1910.16 are not intended to include the discussion in those parts of the coverage of the Longshoremen's and Harbor Workers' Compensation Act or the penalty provisions of the Act. Similarly, the incorporation by reference of Part 1926 in § 1910.12 is not intended to include references to interpretative rules having relevance to the application of the Construction Safety Act, but having no relevance to the application to the Occupational Safety and Health Act.

**§ 1910.12 Construction work.**

(a) *Standards.* The standards prescribed in part 1926 of this chapter are adopted as occupational safety and health standards under section 6 of the Act and shall apply, according to the provisions thereof, to every employment and place of employment of every employee engaged in construction work. Each employer shall protect the employment and places of employment of each of his employees engaged in construction work by complying with the appropriate standards prescribed in this paragraph.

(b) *Definition.* For purposes of this section, "construction work" means work for construction, alteration, and/or repair, including painting and decorating. See discussion of these terms in § 1926.13 of this title.

(c) *Construction Safety Act distinguished.* This section adopts as occupational safety and health standards under section 6 of the Act the standards which are prescribed in part 1926 of this chapter. Thus, the standards (substantive rules) published in subpart C and the following subparts of part 1926 of this chapter are applied. This section does not incorporate subparts A and B of part 1926 of this chapter. Subparts A and B have pertinence only to the application of section 107 of the Contract Work Hours and Safety Standards Act (the Construction Safety Act). For example, the interpretation of the term "subcontractor" in paragraph (c) of § 1926.13 of this chapter is significant in discerning the coverage of the Construction Safety Act and duties thereunder. However, the term "subcontractor" has no significance in the application of the Act, which was enacted under the

Commerce Clause and which establishes duties for "employers" which are not dependent for their application upon any contractual relationship with the Federal Government or upon any form of Federal financial assistance.

**§ 1910.16 Longshoring.**

(a) *Adoption and extension of established safety and health standards for longshoring.* The standards prescribed by part 1504 of this title and in effect on April 28, 1971, are adopted as occupational safety or health standards under section 6(a) of the Act and shall apply, according to the provisions thereof, to every employment and place of employment of every employee engaged in longshoring operations or a related employment. Each employer shall protect the employment and places of employment of each of his employees engaged in a longshoring operation or a related employment, by complying with the appropriate standards prescribed by this paragraph.

(b) *Definitions.* For purposes of this section:

(1) "Longshoring operation" means the loading, unloading, moving, or handling of, cargo, ship's stores, gear, etc., into, in, on, or out of any vessel;

(2) "Related employment" means any employment performed as an incident to or in conjunction with, longshoring operations including, but not restricted to, securing cargo, rigging, and employment as a porter, checker, or watchman; and

(3) "Vessel" includes every description of watercraft or other artificial contrivance used, or capable of being used, as a means of transportation on water, including special purpose floating structures not primarily designed for, or used as a means of, transportation on water.

**§ 1910.19 Special provisions for air contaminants.**

Section 1910.1001 shall apply to the exposure of every employee to asbestos dust in every employment and place of employment covered by § 1910.12, § 1910.13, § 1910.14, § 1910.15, or § 1910.16, in lieu of any different standard on exposure to asbestos dust which would otherwise be applicable by virtue of any of those sections.

## Subpart C—General Safety and Health Provisions

1926.20 General safety and health provisions.
1926.21 Safety training and education.
1926.22 Recording and reporting of injuries. [Reserved]
1926.23 First aid and medical attention.
1926.24 Fire protection and prevention.
1926.25 Housekeeping.
1926.26 Illumination.
1926.27 Sanitation.
1926.28 Personal protective equipment.
*1910.132 General requirements.*
*1910.136 Foot protection.*
1926.29 Acceptable certification.
1926.30 Shipbuilding and ship repairing.
1926.31 Incorporation by reference.
1926.32 Definitions.

**§ 1926.20 General safety and health provisions.**

(a) *Contractor requirements.* (1) Section 107 of the Act requires that it shall be a condition of each contract which is entered into under legislation subject to Reorganization Plan No. 14 of 1950 (64 Stat. 1267), as defined in § 1926.12, and is for construction, alteration, and/or repair, including painting and decorating, that no contractor or subcontractor for any part of the contract work shall require any laborer or mechanic employed in the performance of the contract to work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to his health or safety.

(b) *Accident prevention responsibilities.* (1) It shall be the responsibility of the employer to initiate and maintain such programs as may be necessary to comply with this part.

(2) Such programs shall provide for frequent and regular inspections of the job sites, materials, and equipment to be made by competent persons designated by the employers.

(3) The use of any machinery, tool, material, or equipment which is not in compliance with any applicable requirement of this part is prohibited. Such machine, tool, material, or equipment shall either be identified as unsafe by tagging or locking the controls to render them inoperable or shall be physically removed from its place of operation.

(4) The employer shall permit only those employees qualified by training or experience to operate equipment and machinery.

**§ 1926.21 Safety training and education.**

(a) *General requirements.* The Secretary shall, pursuant to section 107(f) of the Act, establish and supervise programs for the education and training of employers and employees in the recognition, avoidance, and prevention of unsafe conditions in employments covered by the Act.

(b) *Employer responsibility.* (1) The employer should avail himself of the safety and health training programs the Secretary provides.

(2) The employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control or eliminate any hazards or other exposure to illness or injury.

(3) Employees required to handle or use poisons, caustics, and other harmful substances shall be instructed regarding the safe handling and use, and be made aware of the potential hazards, personal hygiene, and personal protective measures required.

(4) In job site areas where harmful plants or animals are present, employees who may be exposed shall be instructed regarding the potential hazards, and how to avoid injury, and the first aid procedures to be used in the event of injury.

(5) Employees required to handle or use flammable liquids, gases, or toxic materials shall be instructed in the safe handling and use of these materials and made aware of the specific requirements contained in subparts D, F, and other applicable subparts of this part.

(6)(i) All employees required to enter into confined or enclosed spaces shall be instructed as to the nature of the hazards involved, the necessary precautions to be taken, and in the use of protective and emergency equipment required. The employer shall comply with any specific regulations that apply to work in dangerous or potentially dangerous areas.

(ii) For purposes of subdivision (i) of this subparagraph, "confined or enclosed space" means any space having a limited means of egress, which is subject to the accumulation of toxic or flammable contaminants or has an oxygen deficient atmosphere. Confined or enclosed spaces include, but are not limited to, storage tanks, process vessels, bins, boilers, ventilation or exhaust ducts, sewers, underground utility vaults, tunnels, pipelines, and open top spaces more than 4 feet in depth such as pits, tubs, vaults, and vessels.

**§ 1926.22 Recording and reporting of injuries. [Reserved]**

**§ 1926.23 First aid and medical attention.**

First aid services and provisions for medical care shall be made available by the employer for every employee covered by these regulations. Regulations prescribing specific requirements for first aid, medical attention, and emergency facilities are contained in subpart D of this part.

**§ 1926.24 Fire protection and prevention.**

The employer shall be responsible for the development and maintenance of an effective fire protection and prevention program at the job site throughout all phases of the construction, repair, alteration, or demolition work. The employer shall insure the

availability of the fire protection and suppression equipment required by subpart F of this part.

**§ 1926.25 Housekeeping.**

(a) During the course of construction, alteration, or repairs, form and scrap lumber with protruding nails, and all other debris, shall be kept cleared from work areas, passageways, and stairs, in and around buildings or other structures.

(b) Combustible scrap and debris shall be removed at regular intervals during the course of construction. Safe means shall be provided to facilitate such removal.

(c) Containers shall be provided for the collection and separation of waste, trash, oily and used rags, and other refuse. Containers used for garbage and other oily, flammable, or hazardous wastes, such as caustics, acids, harmful dusts, etc., shall be equipped with covers. Garbage and other waste shall be disposed of at frequent and regular intervals.

**§ 1926.26 Illumination.**

Construction areas, aisles, stairs, ramps, runways, corridors, offices, shops, and storage areas where work is in progress shall be lighted with either natural or artificial illumination. The minimum illumination requirements for work areas are contained in subpart D of this part.

**§ 1926.27 Sanitation.**

Health and sanitation requirements for drinking water are contained in subpart D of this part.

**§ 1926.28 Personal protective equipment.**

(a) The employer is responsible for requiring the wearing of appropriate personal protective equipment in all operations where there is an exposure to hazardous conditions or where this part indicates the need for using such equipment to reduce the hazards to the employees.

(b) Regulations governing the use, selection, and maintenance of personal protective and lifesaving equipment are described under subpart E of this part.

The following requirements from 29 CFR Part 1910 (General Industry) have been identified as applicable to construction (29 CFR 1926.28—Personal Protective Equipment).

**§ 1910.132 General requirements.**

* * * * *

(b) *Employee-owned equipment.* Where employees provide their own protective equipment, the employer shall be responsible to assure its adequacy, including proper maintenance, and sanitation of such equipment.

(c) *Design.* All personal protective equipment shall be of safe design and construction for the work to be performed.

**§ 1910.136 Occupational foot protection.**

Safety-toe footwear for employees shall meet the requirements and specifications in American National Standard for Men's Safety-Toe Footwear, Z41.1-1967.

---

**§ 1926.29 Acceptable certifications.**

(a) *Pressure vessels.* Current and valid certification by an insurance company or regulatory authority shall be deemed as acceptable evidence of safe installation, inspection, and testing of pressure vessels provided by the employer.

(b) *Boilers.* Boilers provided by the employer shall be deemed to be in compliance with the requirements of this part when evidence of current and valid certification by an insurance company or regulatory authority attesting to the safe installation, inspection, and testing is presented.

(c) *Other requirements.* Regulations prescribing specific requirements for other types of pressure vessels and similar equipment are contained in subparts F and O of this part.

**§ 1926.30 Shipbuilding and ship repairing.**

(a) *General.* Shipbuilding, ship repairing, alterations, and maintenance performed on ships under Government contract, except naval ship construction, is work subject to the Act.

(b) *Applicable safety and health standards.* For the purpose of work carried out under this section, the safety and health regulations promulgated by the Secretary of Labor shall apply: Part 1915 of this title, Safety and Health Regulations for Ship Repairing, and Part 1916 of this title, Safety and Health Regulations for Shipbuilding.

**§ 1926.31 Incorporation by reference.**

(a) The specifications, standards, and codes of agencies of the U.S. Government and organizations which are not agencies of the U.S. Government, to the extent they are legally incorporated by reference in this part, have the same force and effect as other standards in this part. The locations where these specifications, standards, and codes may be examined are as follows:

(1) Offices of the Occupational Safety and Health Administration, U.S. Department of Labor, New Department of Labor Building, 200 Constitution Avenue., NW., Washington, D.C. 20210.

(2) The Regional and Field Offices of the Occupational Safety and Health Administration which are listed in the U.S. Government Manual 1978-79, at page 394.

(b) Any changes in the specifications, standards and codes incorporated by reference in this part and an official historic file of such changes are available at the offices referred to in paragraph (a) of this section. All questions as to the applicability of such changes should also be referred to these offices.

**§ 1926.32 Definitions.**

The following definitions shall apply in the application of the regulations in this part:

(a) "Act" means section 107 of the Contract Work Hours and Safety Standards Act, commonly known as the Construction Safety Act (86 Stat. 96; 40 U.S.C. 333).

(b) "ANSI" means American National Standards Institute.

(c) "Approved" means sanctioned, endorsed, accredited, certified, or accepted as satisfactory by a duly constituted and nationally recognized authority or agency.

(d) "Authorized person" means a person approved or assigned by the employer to perform a specific type of duty or duties or to be at a specific location or locations at the jobsite.

(e) "Administration" means the Occupational Safety and Health Administration.

(f) "Competent person" means one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

(g) "Defect" means any characteristic or condition which tends to weaken or reduce the strength of the tool, object, or structure of which it is a part.

(h) "Designated person" means "authorized person" as defined in paragraph (d) of this section.

(i) "Employee" means every laborer or mechanic under the Act regardless of the contractual relationship which may be alleged to exist between the laborer and mechanic and the contractor or subcontractor who engaged him. "Laborer and mechanic" are not defined in the Act, but the identical terms are used in the Davis-Bacon Act (40 U.S.C. 276a), which provides for minimum wage protection on Federal and federally assisted construction contracts. The use of the same term in a statute which often applies concurrently with section 107 of the Act has considerable precedential value in ascertaining the meaning of "laborer and mechanic" as used in the Act. "La-

borer" generally means one who performs manual labor or who labors at an occupation requiring physical strength; "mechanic" generally means a worker skilled with tools. See 18 Comp. Gen. 341.

(i) "Employer" means contractor or subcontractor within the meaning of the Act and of this part.

(k) "Hazardous substance" means a substance which, by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, or otherwise harmful, is likely to cause death or injury.

(l) "Qualified" means one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated his ability to solve or resolve problems relating to the subject matter, the work, or the project.

(m) "Safety factor" means the ratio of the ultimate breaking strength of a member or piece of material or equipment to the actual working stress or safe load when in use.

(n) "Secretary" means the Secretary of Labor.

(o) "SAE" means Society of Automotive Engineers.

(p) "Shall" means mandatory.

(q) "Should" means recommended.

(r) "Suitable" means that which fits, and has the qualities or qualifications to meet a given purpose, occasion, condition, function, or circumstance.

### Subpart D—Occupational Health and Environmental Controls [1]

Sec.

1926.50 Medical services and first aid.
1926.51 Sanitation.
*1910.141 Sanitation.*
*1910.151 Medical services and first aid.*
1926.52 Occupational noise exposure.
1926.53 Ionizing radiation.
1926.54 Nonionizing radiation.
1926.55 Gases, vapors, fumes, dusts, and mists.
*1910.161 Carbon dioxide use.*
1926.56 Illumination.
1926.57 Ventilation.

### § 1926.50 Medical services and first aid.

(a) The employer shall insure the availability of medical personnel for advice and consultation on matters of occupational health.

(b) Provisions shall be made prior to commencement of the project for prompt medical attention in case of serious injury.

(c) In the absence of an infirmary, clinic, hospital, or physician, that is reasonably accessible in terms of time and distance to the worksite, which is available for the treatment of injured employees, a person who has a valid certificate in first-aid training from the U.S. Bureau of Mines, the American Red Cross, or equivalent training that can be verified by documentary evidence, shall be available at the worksite to render first aid.

(d)(1) First-aid supplies approved by the consulting physician shall be easily accessible when required.

(2) The first-aid kit shall consist of materials approved by the consulting physician in a weatherproof container with individual sealed packages for each type of item. The contents of the first-aid kit shall be checked by the employer before being sent out on each job and at least weekly on each job to ensure that the expended items are replaced.

(e) Proper equipment for prompt transportation of the injured person to a physician or hospital, or a communication system for contacting necessary ambulance service, shall be provided.

(f) The telephone numbers of the physicians, hospitals, or ambulances shall be conspicuously posted.

### § 1926.51 Sanitation.

(a) *Potable water.* (1) An adequate supply of potable water shall be provided in all places of employment.

(2) Portable containers used to dispense drinking water shall be capable of being tightly closed, and equipped with a tap. Water shall not be dipped from containers.

(3) Any container used to distribute drinking water shall be clearly marked as to the nature of its contents and not used for any other purpose.

(4) The common drinking cup is prohibited.

(5) Where single service cups (to be used but once) are supplied, both a sanitary container for the unused cups and a receptacle for disposing of the used cups shall be provided.

(b) *Nonpotable water.* (1) Outlets for nonpotable water, such as water for industrial or firefighting purposes only, shall be identified by signs meeting the requirements of Subpart G of this part, to indicate clearly that the water is unsafe and is not to be used for drinking, washing, or cooking purposes.

(2) There shall be no cross-connection, open or potential, between a system furnishing potable water and a system furnishing nonpotable water.

(c) *Toilets at construction jobsites.* (1) Toilets shall be provided for employees according to the following table:

TABLE D-1

| *Number of employees* | *Minimum number of facilities* |
|---|---|
| 20 or less..... | 1. |
| 20 or more..... | 1 toilet seat and 1 urinal per 40 workers. |
| 200 or more. | 1 toilet seat and 1 urinal per 50 workers. |

(2) Under temporary field conditions, provisions shall be made to assure not less than one toilet facility is available.

(3) Job sites, not provided with a sanitary sewer, shall be provided with one of the following toilet facilities unless prohibited by local codes:

(i) Privies (where their use will not contaminate ground or surface water);

(ii) Chemical toilets;

(iii) Recirculating toilets;

(iv) Combustion toilets.

(4) The requirements of this paragraph (c) for sanitation facilities shall not apply to mobile crews having transportation readily available to nearby toilet facilities.

(d) *Food handling.* All employees' food service facilities and operations shall meet the applicable laws, ordinances, and regulations of the jurisdictions in which they are located.

(e) *Temporary sleeping quarters.* When temporary sleeping quarters are provided, they shall be heated, ventilated, and lighted.

(f) *Washing facilities.* The employer shall provide adequate washing facilities for employees engaged in the application of paints, coating, herbicides, or insecticides, or in other operations where contaminants may be harmful to the employees. Such facilities shall be in near proximity to the worksite and shall be so equipped as to enable employees to remove such substances.

(g) [Revoked.]

The following requirements from 29 CFR Part 1910 (General Industry) have been identified as applicable to construction (29 CFR 1926.51 *Sanitation*), in accordance with their respective scope and definitions.

### § 1910.141 Sanitation.

(a)(1) *Scope.*—This section applies to permanent places of employment.

(2) * * *

(v) "Potable water" means water which meets the quality standards prescribed in the U.S. Public Health Service Drinking Water Standards, published in 42 CFR part 72, or water which is approved for drinking purposes by the State or local authority having jurisdiction.

* * * * *

[1] Portions of the listed Part 1910 standards have been identified as applicable to construction.

(5) *Vermin control.* Every enclosed workplace shall be so constructed, equipped, and maintained, so far as reasonably practicable, as to prevent the entrance or harborage of rodents, insects, and other vermin. A continuing and effective extermination program shall be instituted where their presence is detected.

* * * * *

(g) * * *

(2) *Eating and drinking areas.* No employee shall be allowed to consume food or beverages in a toilet room nor in any area exposed to a toxic material.* * *

(h) All employee food service facilities and operations shall be carried out in accordance with sound hygienic principles. In all places of employment where all or part of the food service is provided, the food dispensed shall be wholesome, free from spoilage, and shall be processed, prepared, handled, and stored in such a manner as to be protected against contamination.

**§ 1910.151 Medical services and first aid.**

* * * * *

(c) Where the eyes or body of any person may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use.

* * * * *

---

**§ 1926.52 Occupational noise exposure.**

(a) Protection against the effects of noise exposure shall be provided when the sound levels exceed those shown in Table D-2 of this section when measured on the A-scale of a standard sound level meter at slow response.

(b) When employees are subjected to sound levels exceeding those listed in Table D-2 of this section, feasible administrative or engineering controls shall be utilized. If such controls fail to reduce sound levels within the levels of the table, personal protective equipment as required in Subpart E, shall be provided and used to reduce sound levels within the levels of the table.

(c) If the variations in noise level involve maxima at intervals of 1 second or less, it is to be considered continuous.

(d)(1) In all cases where the sound levels exceed the values shown herein, a continuing, effective hearing conservation program shall be administered.

TABLE D-2—PERMISSIBLE NOISE EXPOSURES

| Duration per day, hours: | *Sound level dBA slow response* |
|---|---|
| 8 | 90 |
| 6 | 92 |
| 4 | 95 |
| 3 | 97 |
| 2 | 100 |
| 1½ | 102 |
| 1 | 105 |
| ½ | 110 |
| ¼ or less | 115 |

(2)(i) When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. Exposure to different levels for various periods of time shall be computed according to the formula set forth in subdivision (ii) of this subparagraph.

(ii) $F_e=(T_1/L_1)+(T_2/L_2)+\cdots+(T_n/L_n)$

where:

$F_e$=The equivalent noise exposure factor.

$T$=The period of noise exposure at any essentially constant level.

$L$=The duration of the permissible noise exposure at the constant level (from Table D-2).

If the value of $F_e$ exceeds unity (1) the exposure exceeds permissible levels.

(iii) A sample computation showing an application of the formula in subdivision (ii) of this paragraph is as follows. An employee is exposed at these levels for these periods:

110 dB A ¼ hour.
100 dB A ½ hour.
90 dB A 1½ hours.

$$F_e=(¼/½)+(½/2)+(1½/8)$$

$F_e=0.500+0.25+0.188$

$F_e=0.938$

Since the value of $F_e$ does not exceed unity, the exposure is within permissible limits.

(e) Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

**§ 1926.53 Ionizing radiation.**

(a) In construction and related activities involving the use of sources of ionizing radiation, the pertinent provisions of the Atomic Energy Commission's Standards for Protection Against Radiation (10 CFR Part 20), relating to protection against occupational radiation exposure, shall apply.

(b) Any activity which involves the use of radioactive materials or X-rays, whether or not under license from the Atomic Energy Commission, shall be performed by competent persons specially trained in the proper and safe operation of such equipment. In the case of materials used under Commission license, only persons actually licensed, or competent persons under direction and supervision of the licensee, shall perform such work.

**§ 1926.54 Nonionizing radiation.**

(a) Only qualified and trained employees shall be assigned to install, adjust, and operate laser equipment.

(b) Proof of qualification of the laser equipment operator shall be available and in possession of the operator at all times.

(c) Employees, when working in areas in which a potential exposure to direct or reflected laser light greater than 0.005 watts (5 milliwatts) exists, shall be provided with antilaser eye protection devices as specified in Subpart E of this part.

(d) Areas in which lasers are used shall be posted with standard laser warning placards.

(e) Beam shutters or caps shall be utilized, or the laser turned off, when laser transmission is not actually required. When the laser is left unattended for a substantial period of time, such as during lunch hour, overnight, or at change of shifts, the laser shall be turned off.

(f) Only mechanical or electronic means shall be used as a detector for guiding the internal alignment of the laser.

(g) The laser beam shall not be directed at employees.

(h) When it is raining or snowing, or when there is dust or fog in the air, the operation of laser systems shall be prohibited where practicable; in any event, employees shall be kept out of range of the area of source and target during such weather conditions.

(i) Laser equipment shall bear a label to indicate maximum output.

(j) Employees shall not be exposed to light intensities above:

(1) Direct staring: 1 micro-watt per square centimeter;

(2) Incidental observing: 1 milliwatt per square centimeter;

(3) Diffused reflected light: 2½ watts per square centimeter.

(k) Laser unit in operation should be set up above the heads of the employees, when possible.

(l) Employees shall not be exposed to microwave power densities in excess of 10 milliwatts per square centimeter.

**§ 1926.55 Gases, vapors, fumes, dusts, and mists.**

(a) Exposure of employees to inhalation, ingestion, skin absorption, or contact with any material or substance at a concentration above those specified in the "Threshold Limit Values of Airborne Contaminants for 1970" of the American Conference of Governmental Industrial Hygienists, shall be avoided.

(b) To achieve compliance with paragraph (a) of this section, administrative or engineering controls must first be implemented whenever feasible. When such controls are not feasible to achieve full compliance, protective equipment or other protective measures shall be used to keep the exposure of employees to air contaminants within the limits prescribed in this section. Any equipment and technical measures used for this purpose must first be approved for each particular use by a competent industrial hygienist or other technically qualified person. Whenever respirators are used, their use shall comply with § 1926.103.

(c) Paragraphs (a) and (b) of this section do not apply to the exposure of employees to airborne asbestos dust. Whenever any employee is exposed to airborne asbestos dust, the requirements of § 1910.1001 of this title shall apply.

The following requirement from 29 CFR Part 1910 (General Industry) has been identified as applicable to construction (29 CFR 1926.55 *Gases, vapors, fumes, dusts and mists*).

**§ 1910.161 Carbon dioxide extinguishing systems.**

(a) * * *

(2) *Safety requirements.* In any use of carbon dioxide where there is a possibility that employees may be trapped in, or enter into atmospheres made hazardous by a carbon dioxide discharge, suitable safeguards shall be provided to insure prompt evacuation of and to prevent entry into such atmospheres and also to provide means for prompt rescue of any trapped personnel. Such safety items as personnel training, warning signs, discharge alarms, predischarge alarms, and breathing apparatus shall be considered.

---

**§ 1926.56 Illumination.**

(a) *General.* Construction areas, ramps, runways, corridors, offices, shops, and storage areas shall be lighted to not less than the minimum illumination intensities listed in Table D-3 while any work is in progress:

TABLE D-3—MINIMUM ILLUMINATION INTENSITIES IN FOOT-CANDLES

| Foot-candles: | *Area or operation* |
|---|---|
| 5 | General construction area lighting. |
| 3 | General construction areas, concrete placement, excavation and waste areas, accessways, active storage areas, loading platforms, refueling, and field maintenance areas. |
| 5 | Indoors: warehouses, corridors, hallways, and exitways. |
| 5 | Tunnels, shafts, and general underground work areas: (Exception: minimum of 10 foot-candles is required at tunnel and shaft heading during drilling, mucking, and scaling. Bureau of Mines approved cap lights shall be acceptable for use in the tunnel heading.) |
| 10 | General construction plant and shops (e.g., batch plants, screening plants, mechanical and electrical equipment rooms, carpenter shops, rigging lofts and active storerooms, barracks or living quarters, locker or dressing rooms, mess halls, and indoor toilets and workrooms). |
| 30 | First aid stations, infirmaries, and offices. |

(b) *Other areas.* For areas or operations not covered above, refer to the American National Standard A11.1-1965, R1970, Practice for Industrial Lighting, for recommended values of illumination.

**§ 1926.57 Ventilation.**

(a) *General.* Whenever hazardous substances such as dusts, fumes, mists, vapors, or gases exist or are produced in the course of construction work, their concentrations shall not exceed the limits specified in § 1926.55(a). When ventilation is used as an engineering control method, the system shall be installed and operated according to the requirements of this section.

(b) *Local exhaust ventilation.* Local exhaust ventilation when used as described in (a) shall be designed to prevent dispersion into the air of dusts, fumes, mists, vapors, and gases in concentrations causing harmful exposure. Such exhaust systems shall be so designed that dusts, fumes, mists, vapors, or gases are not drawn through the work area of employees.

(c) *Design and operation.* Exhaust fans, jets, ducts, hoods, separators, and all necessary appurtenances, including refuse receptacles, shall be so designed, constructed, maintained and operated as to ensure the required protection by maintaining a volume and velocity of exhaust air sufficient to gather dusts, fumes, vapors, or gases from said equipment or process, and to convey them to suitable points of safe disposal, thereby preventing their dispersion in harmful quantities into the atmosphere where employees work.

(d) *Duration of operations.* (1) The exhaust system shall be in operation continually during all operations which it is designed to serve. If the employee remains in the contaminated zone, the system shall continue to operate after the cessation of said operations, the length of time to depend upon the individual circumstances and effectiveness of the general ventilation system.

(2) Since dust capable of causing disability is, according to the best medical opinion, of microscopic size, tending to remain for hours in suspension in still air, it is essential that the exhaust system be continued in operation for a time after the work process or equipment served by the same shall have ceased, in order to ensure the removal of the harmful elements to the required extent. For the same reason, employees wearing respiratory equipment should not remove same immediately until the atmosphere seems clear.

(e) *Disposal of exhaust materials.* The air outlet from every dust separator, and the dusts, fumes, mists, vapors, or gases collected by an exhaust or ventilating system shall discharge to the outside atmosphere. Collecting systems which return air to work area may be used if concentrations which accumulate in the work area air do not result in harmful exposure to employees. Dust and refuse discharged from an exhaust system shall be disposed of in such a manner that it will not result in harmful exposure to employees.

## Subpart E—Personal Protective and Life Saving Equipment [1]

Sec.

1926.100 Head protection.
1926.101 Hearing protection.
1926.102 Eye and face protection.
1926.103 Respiratory protection.
*1910.94 Ventilation.*
*1910.134 Respiratory protection.*
1926.104 Safety belts, lifelines, and lanyards.
1926.105 Safety nets.
1926.106 Working over or near water.
1926.107 Definitions applicable to this subpart.

**§ 1926.100 Head protection.**

(a) Employees working in areas where there is a possible danger of head injury from impact, or from falling or flying objects, or from electrical shock and burns, shall be protected by protective helmets.

(b) Helmets for the protection of employees against impact and penetration of falling and flying objects shall meet the specifications contained in American National Standards Institute, Z89.1-1969, Safety Requirements for Industrial Head Protection.

(c) Helmets for the head protection of employees exposed to high voltage electrical shock and burns shall meet the specifications contained in American National Standards Institute, Z89.2-1971.

**§ 1926.101 Hearing protection.**

(a) Wherever it is not feasible to reduce the noise levels or duration of exposures to those specified in Table D-2, Permissible Noise Exposures, in

---

[1] Portions of the listed Part 1910 standards have been identified as applicable to construction.

§ 1926.52, ear protective devices shall be provided and used.

(b) Ear protective devices inserted in the ear shall be fitted or determined individually by competent persons.

(c) Plain cotton is not an acceptable protective device.

**§ 1926.102 Eye and face protection.**

(a) *General.* (1) Employees shall be provided with eye and face protection equipment when machines or operations present potential eye or face injury from physical, chemical, or radiation agents.

(2) Eye and face protection equipment required by this Part shall meet the requirements specified in American National Standards Institute, Z87.1-1968, Practice for Occupational and Educational Eye and Face Protection.

(3) Employees whose vision requires the use of corrective lenses in spectacles, when required by this regulation to wear eye protection, shall be protected by goggles or spectacles of one of the following types:

(i) Spectacles whose protective lenses provide optical correction;

(ii) Goggles that can be worn over corrective spectacles without disturbing the adjustment of the spectacles;

(iii) Goggles that incorporate corrective lenses mounted behind the protective lenses.

(4) Face and eye protection equipment shall be kept clean and in good repair. The use of this type equipment with structural or optical defects shall be prohibited.

(5) Table E-1 shall be used as a guide in the selection of face and eye protection for the hazards and operations noted.

TABLE E-1—EYE AND FACE PROTECTOR SELECTION GUIDE

1. GOGGLES, Flexible Fitting, Regular Ventilation
2. GOGGLES, Flexible Fitting, Hooded Ventilation
3. GOGGLES, Cushioned Fitting, Rigid Body
*4. SPECTACLES, Metal Frame, with Sideshields
*5. SPECTACLES, Plastic Frame, with Sideshields
*6. SPECTACLES, Metal-Plastic Frame, with Sideshields
** 7. WELDING GOGGLES, Eyecup Type, Tinted Lenses (Illustrated)
7A. CHIPPING GOGGLES, Eyecup Type, Clear Safety Lenses (Not Illustrated)
** 8. WELDING GOGGLES, Coverspec Type Tinted Lenses (Illustrated)
8A. CHIPPING GOGGLES, Coverspec Type, Clear Safety Lenses (Not Illustrated)
** 9. WELDING GOGGLES, Coverspec Type, Tinted Plate Lens
10. FACE SHIELD (Available with Plastic or Mesh Window)
**11. WELDING HELMETS

*Non-side shield spectacles are available for limited hazard use requiring only frontal protection.

**See Table E-2, in paragraph (b) of this section, Filter Lens Shade Numbers for Protection Against Radiant Energy.

APPLICATIONS

| Operation | Hazards | Recommended Protectors: Bold Type Numbers Signify Preferred Protection |
|---|---|---|
| Acetylene—Burning, Acetylene—Cutting, Acetylene—Welding. | Sparks, harmful rays, molten metal, flying particles. | 7, 8, 9. |
| Chemical Handling | Splash, acid burns, fumes. | 2, 10 (For severe exposure add 10 over 2). |
| Chipping | Flying particles | 1, 3, 4, 5, 6, 7A, 8A. |
| Electric (arc) welding | Sparks, intense rays, molten metal. | 9, 11, (11 in combination with 4, 5, 6, in tinted lenses, advisable). |
| Furnace operations | Glare, heat, molten metal. | 7, 8, 9 (For severe exposure add 10). |
| Grinding—Light | Flying particles | 1, 3, 4, 5, 6, 10. |
| Grinding—Heavy | Flying particles | 1 , 3, 7A, 8A (For severe exposure add 10). |
| Laboratory | Chemical splash, glass breakage. | 2 (10 when in combination with 4, 5, 6). |
| Machining | Flying particles | 1, 3, 4, 5, 6, 10. |
| Molten metals | Heat, glare, sparks, splash. | 7, 8, (10 in combination with 4, 5, 6, in tinted lenses). |
| Spot welding | Flying particles, sparks | 1, 3, 4, 5, 6, 10. |

[4510-26-M]

(b) *Protection against radiant energy*—(1) *Selection of shade numbers for welding filter.* Table E-2 shall be used as a guide for the selection of the proper shade numbers of filter lenses or plates used in welding. Shades more dense than those listed may be used to suit the individual's needs.

TABLE E-2—FILTER LENS SHADE NUMBERS FOR PROTECTION AGAINST RADIANT ENERGY

| Welding operation | Shade number |
|---|---|
| Shielded metal-arc welding 1/16-, 3/32-, 1/8-, 5/32-inch diameter electrodes | 10 |
| Gas-shielded arc welding (nonferrous) 1/16-, 3/32-, 1/8-, 5/32-inch diameter electrodes | 11 |
| Gas-shielded arc welding (ferrous) 1/16-, 3/32-, 1/8-, 5/32-inch diameter electrodes | 12 |
| Shielded metal-arc welding 5/16-, 1/32-, 1/4-inch diameter electrodes | 12 |
| 5/16-, 3/8-inch diameter electrodes | 14 |
| Atomic hydrogen welding | 10-14 |
| Carbon-arc welding | 14 |
| Soldering | 2 |
| Torch brazing | 3 or 4 |
| Light cutting, up to 1 inch | 3 or 4 |
| Medium cutting, 1 inch to 6 inches | 4 or 5 |
| Heavy cutting, over 6 inches | 5 or 6 |
| Gas welding (light), up to 1/8-inch | 4 or 5 |
| Gas welding (medium), 1/8-inch to 1/2-inch | 5 or 6 |
| Gas welding (heavy), over 1/2-inch | 6 or 8 |

(2) *Laser protection.* (i) Employees whose occupation or assignment requires exposure to laser beams shall be furnished suitable laser safety goggles which will protect for the specific wavelength of the laser and be of optical density (O.D.) adequate for the energy involved. Table E-3 lists the maximum power or energy density for which adequate protection is afforded by glasses of optical densities from 5 through 8.

TABLE E-3—SELECTING LASER SAFETY GLASS

| INTENSITY | ATTENUATION | |
|---|---|---|
| CW maximum power density (watts/cm$^2$) | Optical density (O.D.) | Attenuation factor |
| $10^{-2}$ | 5 | $10^5$ |
| $10^{-1}$ | 6 | $10^6$ |
| 1.0 | 7 | $10^7$ |
| 10.0 | 8 | $10^8$ |

Output levels falling between lines in this table shall require the higher optical density.

(ii) All protective goggles shall bear a label identifying the following data:

(*a*) The laser wavelengths for which use is intended;

(*b*) The optical density of those wavelengths;

(*c*) The visible light transmission.

§ 1926.103 Respiratory protection.

(a) *General.* (1) In emergencies, or when controls required by Subpart D of this part either fail or are inadequate to prevent harmful exposure to employees, appropriate respiratory protective devices shall be provided by the employer and shall be used.

(2) Respiratory protective devices shall be approved by the U.S. Bureau of Mines or acceptable to the U.S. Department of Labor for the specific contaminant to which the employee is exposed.

(b) *Respirator selection.* (1) The chemical and physical properties of the contaminant, as well as the toxicity and concentration of the hazardous material, shall be considered in selecting the proper respirators.

(2) The nature and extent of the hazard, work requirements, and conditions, as well as the limitations and characteristics of the available respirators, shall also be factors considered in making the proper selection.

(3) The following table lists the types of respirators required for protection in dangerous atmospheres:

TABLE E-4.—SELECTION OF RESPIRATORS

| Hazard | Respirator (See Note) |
|---|---|
| Oxygen deficiency | Self-contained breathing apparatus. Hose mask with blower. Combination air-line respirator with auxiliary self-contained air supply or an air-storage receiver with alarm. |
| Gas and vapor contaminants immediately dangerous to life and health. | Self-contained breathing apparatus. Hose mask with blower. Air-purifying, full facepiece respirator with chemical canister (gas mask). Self-rescue mouthpiece respirator (for escape only). Combination air-line respirator with auxiliary self-contained air supply or an air-storage receiver with alarm. |
| Not immediately dangerous to life and health | Air-line respirator.<br>Hose mask without blower.<br>Air-purifying, half-mask or mouthpiece respirator with chemical cartridge. |
| Particulate contaminants immediately dangerous to life and health. | Self-contained breathing apparatus.<br>Hose mask with blower.<br>Air-purifying, full facepiece respirator with appropriate filter.<br>Self-rescue mouthpiece respirator (for escape only).<br>Combination air-line respirator with auxiliary self-contained air supply or an air-storage receiver with alarm. |
| Not immediately dangerous to life and health | Air-purifying, half-mask or mouthpiece respirator with filter pad or cartridge.<br>Air-line respirator.<br>Air-line abrasive-blasting respirator.<br>Hose-mask without blower. |
| Combination gas, vapor, and particulate contaminants immediately dangerous to life and health. | Self-contained breathing apparatus.<br>Hose mask with blower.<br>Air-purifying, full facepiece respirator with chemical canister and appropriate filter (gas mask with filter).<br>Self-rescue mouthpiece respirator (for escape only).<br>Combination air-line respirator with auxiliary self-contained air supply or an air-storage receiver with alarm. |
| Not immediately dangerous to life and health | Air-line respirator.<br>Hose mask without blower.<br>Air-purifying, half-mask or mouthpiece respirator with chemical cartridge and appropriate filter. |

NOTE: For the purpose of this part, "immediately dangerous to life and health" is defined as a condition that either poses an immediate threat to life and health or an immediate threat of severe exposure to contaminants, such as radioactive materials, which are likely to have adverse delayed effects on health.

(c) *Selection, issuance, use and care of respirators.* (1) Employees required to use respiratory protective equipment approved for use in atmospheres immediately dangerous to life shall be thoroughly trained in its use. Employees required to use other types of respiratory protective equipment shall be instructed in the use and limitations of such equipment.

(2) Respiratory protective equipment shall be inspected regularly and maintained in good condition. Gas mask canisters and chemical cartridges shall be replaced as necessary so as to provide complete protection. Mechanical filters shall be cleaned or replaced as necessary so as to avoid undue resistance to breathing.

(3) Respiratory protective equipment which has been previously used shall be cleaned and disinfected before it is issued by the employer to another employee. Emergency rescue equip-

ment shall be cleaned and disinfected immediately after each use.

The following requirements from 29 CFR Part 1910 (General Industry) have been identified as applicable to construction (29 CFR 1926.103 *Respiratory protection*), in accordance with their respective scope and definitions.

**§ 1910.94 Ventilation.**

(a) *Abrasive blasting.*—(1) *Definitions applicable to this paragraph* * * *

(ii) *Abrasive-blasting respirator.* A continuous flow air-line respirator constructed so that it will cover the wearer's head, neck, and shoulders to protect him from rebounding abrasive.

* * * * *

(5) *Personal protective equipment.* (i) Only respiratory protective equipment approved by the Bureau of Mines, U.S. Department of the Interior (see 30 CFR Part 11) shall be used for protection of personnel against dusts produced during abrasive-blasting operations.

(ii) Abrasive-blasting respirators shall be worn by all abrasive-blasting operators: * * *

(B) When using silica sand in manual blasting operations where the nozzle and blast are not physically separated from the operator in an exhaust ventilated enclosure.

* * * * *

(8) *Scope.* This paragraph (a) applies to all operations where an abrasive is forcibly applied to a surface by pneumatic or hydraulic pressure, or by centrifugal force. It does not apply to steam blasting, or steam cleaning, or hydraulic cleaning methods where work is done without the aid of abrasives.

* * * * *

**§ 1910.134 Respiratory protection.**

(a) *Permissible practice.* (1) In the control of those occupational diseases caused by breathing air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, sprays, or vapors, the primary objective shall be to prevent atmospheric contamination. This shall be accomplished as far as feasible by accepted engineering control measures (for example, enclosure or confinement of the operation, general and local ventilation, and substitution of less toxic materials). When effective engineering controls are not feasible, or while they are being instituted, appropriate respirators shall be used pursuant to the following requirements.

(2) Respirators shall be provided by the employer when such equipment is necessary to protect the health of the employee. The employer shall provide the respirators which are applicable and suitable for the purpose intended. The employer shall be responsible for the establishment and maintenance of a respiratory protective program which shall include the requirements outlined in paragraph (b) of this section.

(3) The employee shall use the provided respiratory protection in accordance with instructions and training received.

(b) *Requirements for a minimal acceptable program.* (1) Written standard operating procedures governing the selection and use of respirators shall be established.

(2) Respirators shall be selected on the basis of hazards to which the worker is exposed.

(3) The user shall be instructed and trained in the proper use of respirators and their limitations.

(4) Where practicable, the respirators should be assigned to individual workers for their exclusive use.

(5) Respirators shall be regularly cleaned and disinfected. Those issued for the exclusive use of one worker should be cleaned after each day's use, or more often if necessary. Those used by more than one worker shall be thoroughly cleaned and disinfected after each use.

(6) Respirators shall be stored in a convenient, clean, and sanitary location.

(7) Respirators used routinely shall be inspected during cleaning. Worn or deteriorated parts shall be replaced. Respirators for emergency use such as self-contained devices shall be thoroughly inspected at least once a month and after each use.

(8) Appropriate surveillance of work area conditions and degree of employee exposure or stress shall be maintained.

(9) There shall be regular inspection and evaluation to determine the continued effectiveness of the program.

(10) Persons should not be assigned to tasks requiring use of respirators unless it has been determined that they are physically able to perform the work and use the equipment. The local physician shall determine what health and physical conditions are pertinent. The respirator user's medical status should be reviewed periodically (for instance, annually).

(11) Approved or accepted respirators shall be used when they are available. The respirator furnished shall provide adequate respiratory protection against the particular hazard for which it is designed in accordance with standards established by competent authorities. The U.S. Department of Interior, Bureau of Mines, and the U.S. Department of Agriculture are recognized as such authorities. Although respirators listed by the U.S. Department of Agriculture continue to be acceptable for protection against specified pesticides, the U.S. Department of the Interior, Bureau of Mines, is the agency now responsible for testing and approving pesticide respirators.

(c) *Selection of respirators.* Proper selection of respirators shall be made according to the guidance of American National Standard Practices for Respiratory Protection Z88.2-1969.

(d) *Air quality.* (1) Compressed air, compressed oxygen, liquid air, and liquid oxygen used for respiration shall be of high purity. Oxygen shall meet the requirements of the United States Pharmacopoeia for medical or breathing oxygen. Breathing air shall meet at least the requirements of the specification for Grade D breathing air as described in Compressed Gas Association Commodity Specification G-7.1-1966. Compressed oxygen shall not be used in supplied-air respirators or in open circuit self-contained breathing apparatus that have previously used compressed air. Oxygen must never be used with air line respirators.

(2) Breathing air may be supplied to respirators from cylinders or air compressors.

(i) Cylinders shall be tested and maintained as prescribed in the Shipping Container Specification Regulations of the Department of Transportation (49 CFR Part 178).

(ii) The compressor for supplying air shall be equipped with necessary safety and standby devices. A breathing air-type compressor shall be used. Compressors shall be constructed and situated so as to avoid entry of contaminated air into the system and suitable in-line air purifying sorbent beds and filters installed to further assure breathing air quality. A receiver of sufficient capacity to enable the respirator wearer to escape from a contaminated atmosphere in event of compressor failure, and alarms to indicate compressor failure and overheating shall be installed in the system. If an oil-lubricated compressor is used, it shall have a

high-temperature or carbon monoxide alarm, or both. If only a high-temperature alarm is used, the air from the compressor shall be frequently tested for carbon monoxide to insure that it meets the specifications in subparagraph (1) of this section.

(3) Air line couplings shall be incompatible with outlets for other gas systems to prevent inadvertent servicing of air line respirators with nonrespirable gases or oxygen.

(4) Breathing gas containers shall be marked in accordance with American National Standard Method of Marking Portable Compressed Gas Containers to Identify the Material Contained, Z48.1–1954; Federal Specification BB–A–1034a, June 21, 1968, Air, Compressed for Breathing Purposes; or Interim Federal Specification GG–B–00675b, April 27, 1965, Breathing Apparatus, Self-Contained.

(e) *Use of respirators.* (1) Standard procedures shall be developed for respirator use. These should include all information and guidance necessary for their proper selection, use, and care. Possible emergency and routine uses of respirators should be anticipated and planned for.

(2) The correct respirator shall be specified for each job. The respirator type is usually specified in the work procedures by a qualified individual supervising the respiratory protective program. The individual issuing them shall be adequately instructed to insure that the correct respirator is issued. Each respirator permanently assigned to an individual should be durably marked to indicate to whom it was assigned. This mark shall not affect the respirator performance in any way. The date of issuance should be recorded.

(3) Written procedures shall be prepared covering safe use of respirators in dangerous atmospheres that might be encountered in normal operations or in emergencies. Personnel shall be familiar with these procedures and the available respirators.

(i) In areas where the wearer, with failure of the respirator, could be overcome by a toxic or oxygen-deficient atmosphere, at least one additional man shall be present. Communications (visual, voice, or signal line) shall be maintained between both or all individuals present. Planning shall be such that one individual will be unaffected by any likely incident and have the proper rescue equipment to be able to assist the other(s) in case of emergency.

(ii) When self-contained breathing apparatus or hose masks with blowers are used in atmospheres immediately dangerous to life or health, standby men must be present with suitable rescue equipment.

(iii) Persons using air line respirators in atmospheres immediately hazardous to life or health shall be equipped with safety harnesses and safety lines for lifting or removing persons from hazardous atmospheres or other and equivalent provisions for the rescue of persons from hazardous atmospheres shall be used. A standby man or men with suitable self-contained breathing apparatus shall be at the nearest fresh air base for emergency rescue.

(4) Respiratory protection is no better than the respirator in use, even though it is worn conscientiously. Frequent random inspections shall be conducted by a qualified individual to assure that respirators are properly selected, used, cleaned, and maintained.

(5) For safe use of any respirator, it is essential that the user be properly instructed in its selection, use, and maintenance. Both supervisors and workers shall be so instructed by competent persons. Training shall provide the men an opportunity to handle the respirator, have it fitted properly, test its face-piece-to-face seal, wear it in normal air for a long familiarity period, and, finally, to wear it in a test atmosphere.

(i) Every respirator wearer shall receive fitting instructions including demonstrations and practice in how the respirator should be worn, how to adjust it, and how to determine if it fits properly. Respirators shall not be worn when conditions prevent a good face seal. Such conditions may be a growth of beard, sideburns, a skull cap that projects under the facepiece, or temple pieces on glasses. Also, the absence of one or both dentures can seriously affect the fit of a facepiece. The worker's diligence in observing these factors shall be evaluated by periodic check. To assure proper protection, the facepiece fit shall be checked by the wearer each time he puts on the respirator. This may be done by following the manufacturer's facepiece fitting instructions.

(ii) Providing respiratory protection for individuals wearing corrective glasses is a serious problem. A proper seal cannot be established if the temple bars of eye glasses extend through the sealing edge of the full facepiece. As a temporary measure, glasses with short temple bars or without temple bars may be taped to the wearer's head. Wearing of contact lenses in contaminated atmospheres with a respirator shall not be allowed. Systems have been developed for mounting corrective lenses inside full facepieces. When a workman must wear corrective lenses as part of the facepiece, the facepiece and lenses shall be fitted by qualified individuals to provide good vision, comfort, and a gas-tight seal.

(iii) If corrective spectacles or goggles are required, they shall be worn so as not to affect the fit of the facepiece. Proper selection of equipment will minimize or avoid this problem.

(f) *Maintenance and care of respirators.* (1) A program for maintenance and care of respirators shall be adjusted to the type of plant, working conditions, and hazards involved, and shall include the following basic services:

(i) Inspection for defects (including a leak check),

(ii) Cleaning and disinfecting,

(iii) Repair,

(iv) Storage.

Equipment shall be properly maintained to retain its original effectiveness.

(2)(i) All respirators shall be inspected routinely before and after each use. A respirator that is not routinely used but is kept ready for emergency use shall be inspected after each use and at least monthly to assure that it is in satisfactory working condition.

(ii) Self-contained breathing apparatus shall be inspected monthly. Air and oxygen cylinders shall be fully charged according to the manufacturer's instructions. It shall be determined that the regulator and warning devices function properly.

(iii) Respirator inspection shall include a check of the tightness of connections and the condition of the facepiece, headbands, valves, connecting tube, and canisters. Rubber or elastomer parts shall be inspected for pliability and signs of deterioration. Stretching and manipulating rubber or elastomer parts with a massaging action will keep them pliable and flexible and prevent them from taking a set during storage.

(iv) A record shall be kept of inspection dates and findings for respirators maintained for emergency use.

(3) Routinely used respirators shall be collected, cleaned, and disinfected as frequently as necessary to insure that proper protection is provided for the wearer. Each worker should be briefed on the

cleaning procedure and be assured that he will always receive a clean and disinfected respirator. Such assurances are of greatest significance when respirators are not individually assigned to workers. Respirators maintained for emergency use shall be cleaned and disinfected after each use.

(4) Replacement or repairs shall be done only by experienced persons with parts designed for the respirator. No attempt shall be made to replace components or to make adjustment or repairs beyond the manufacturer's recommendations. Reducing or admission valves or regulators shall be returned to the manufacturer or to a trained technician for adjustment or repair.

(5) (i) After inspection, cleaning, and necessary repair, respirators shall be stored to protect against dust, sunlight, heat, extreme cold, excessive moisture, or damaging chemicals. Respirators placed at stations and work areas for emergency use should be quickly accessible at all times and should be stored in compartments built for the purpose. The compartments should be clearly marked. Routinely used respirators, such as dust respirators, may be placed in plastic bags. Respirators should not be stored in such places as lockers or tool boxes unless they are in carrying cases or cartons.

(ii) Respirators should be packed or stored so that the facepiece and exhalation valve will rest in a normal position and function will not be impaired by the elastomer setting in an abnormal position.

(iii) Instructions for proper storage of emergency respirators, such as gas masks and self-contained breathing apparatus, are found in "use and care" instructions usually mounted inside the carrying case lid.

(g) *Identification of gas mask canisters.* (1) The primary means of identifying a gas mask canister shall be by means of properly worded labels. The secondary means of identifying a gas mask canister shall be by a color code.

(2) All who issue or use gas masks falling within the scope of this section shall see that all gas mask canisters purchased or used by them are properly labeled and colored in accordance with these requirements before they are placed in service and that the labels and colors are properly maintained at all times thereafter until the canisters have completely served their purpose.

(3) On each canister shall appear in bold letters the following:

(i)—

Canister for _____
(Name for atmospheric contaminant)

or

Type N Gas Mask Canister

(ii) In addition, essentially the following wording shall appear beneath the appropriate phrase on the canister label: "For respiratory protection in atmospheres containing not more than _____ percent by volume of _____."

(4) Canisters having a special high- efficiency filter for protection against radionuclides and other highly toxic particulates shall be labeled with a statement of the type and degree of protection afforded by the filter. The label shall be affixed to the neck end of, or to the gray stripe which is around and near the top of, the canister. The degree of protection shall be marked as the percent of penetration of the canister by a 0.3-micron-diameter dioctyl phthalate (DOP) smoke at a flow rate of 85 liters per minute.

(5) Each canister shall have a label warning that gas masks should be used only in atmospheres containing sufficient oxygen to support life (at least 16 percent by volume), since gas mask canisters are only designed to neutralize or remove contaminants from the air.

(6) Each gas mask canister shall be painted a distinctive color or combination of colors indicated in Table I-1. All colors used shall be such that they are clearly identifiable by the user and clearly distinguishable from one another. The color coating used shall offer a high degree of resistance to chipping, scaling, peeling, blistering, fading, and the effects of the ordinary atmospheres to which they may be exposed under normal conditions of storage and use. Appropriately colored pressure sensitive tape may be used for the stripes.

TABLE 1-1

| *Atmospheric contaminants to be protected against* | *Colors assigned** |
|---|---|
| Acid gases | White. |
| Hydrocyanic acid gas | White with ⅛-inch green stripe completely around the canister near the bottom. |
| Chlorine gas | White with ½-inch yellow stripe completely around the canister near the bottom. |
| Organic vapors | Black. |
| Ammonia gas | Green. |
| Acid gases and ammonia gas | Green with ⅛-inch white stripe completely around the canister near the bottom. |
| Carbon monoxide | Blue. |
| Acid gases and organic vapors | Yellow. |
| Hydrocyanic acid gas and chloropicrin vapor | Yellow with ½-inch blue stripe completely around the canister near the bottom. |
| Acid gases, organic vapors, and ammonia gases. | Brown. |
| Radioactive materials, excepting tritium and noble gases. | Purple (Magenta). |
| Particulates (dusts, fumes, mists, fogs, or smokes) in combination with any of the above gases or vapors. | Canister color for contaminant, as designated above, with ½-inch gray stripe completely around the canister near the top. |
| All of the above atmospheric contaminants | Red with ½-inch gray stripe completely around the canister near the top. |

*Gray shall not be assigned as the main color for a canister designed to remove acids or vapors.

NOTE: Orange shall be used as a complete body, or stripe color to represent gases not included in this table. The user will need to refer to the canister label to determine the degree of protection the canister will afford.

**§ 1926.104 Safety belts, lifelines, and lanyards.**

(a) Lifelines, safety belts, and lanyards shall be used only for employee safeguarding. Any lifeline, safety belt, or lanyard actually subjected to in-service loading, as distinguished from static load testing, shall be immediately removed from service and shall not be used again for employee safeguarding.

(b) Lifelines shall be secured above the point of operation to an anchorage or structural member capable of supporting a minimum dead weight of 5,400 pounds.

(c) Lifelines used on rock-scaling operations, or in areas where the lifeline may be subjected to cutting or abrasion, shall be a minimum of ⅞-inch wire core manila rope. For all other lifeline applications, a minimum of ¾-inch manila or equivalent, with a minimum breaking strength of 5,400 pounds, shall be used.

(d) Safety belt lanyard shall be a minimum of ½-inch nylon, or equivalent, with a maximum length to provide for a fall of no greater than 6 feet. The rope shall have a nominal breaking strength of 5,400 pounds.

(e) All safety belt and lanyard hardware shall be drop forged or pressed steel, cadmium plated in accordance with type 1, Class B plating specified in Federal Specification QQ-P-416. Surface shall be smooth and free of sharp edges.

(f) All safety belt and lanyard hardware, except rivets, shall be capable of withstanding a tensile loading of 4,000 pounds without cracking, breaking, or taking a permanent deformation.

**§ 1926.105 Safety nets.**

(a) Safety nets shall be provided when workplaces are more than 25 feet above the ground or water surface, or other surfaces where the use of ladders, scaffolds, catch platforms, temporary floors, safety lines, or safety belts is impractical.

(b) Where safety net protection is required by this part, operations shall not be undertaken until the net is in place and has been tested.

(c)(1) Nets shall extend 8 feet beyond the edge of the work surface where employees are exposed and shall be installed as close under the work surface as practical but in no case more than 25 feet below such work surface. Nets shall be hung with sufficient clearance to prevent user's contact with the surfaces or structures below. Such clearances shall be determined by impact load testing.

(2) It is intended that only one level of nets be required for bridge construction.

(d) The mesh size of nets shall not exceed 6 inches by 6 inches. All new nets shall meet accepted performance standards of 17,500 foot-pounds minimum impact resistance as determined and certified by the manufacturers, and shall bear a label of proof test. Edge ropes shall provide a minimum breaking strength of 5,000 pounds.

(e) Forged steel safety hooks or shackles shall be used to fasten the net to its supports.

(f) Connections between net panels shall develop the full strength of the net.

**§ 1926.106 Working over or near water.**

(a) Employees working over or near water, where the danger of drowning exists, shall be provided with U.S. Coast Guard-approved life jacket or buoyant work vests.

(b) Prior to and after each use, the buoyant work vests or life preservers shall be inspected for defects which would alter their strength or buoyancy. Defective units shall not be used.

(c) Ring buoys with at least 90 feet of line shall be provided and readily available for emergency rescue operations. Distance between ring buoys shall not exceed 200 feet.

(d) At least one lifesaving skiff shall be immediately available at locations where employees are working over or adjacent to water.

**§ 1926.107 Definitions applicable to this subpart.**

(a) "Contaminant" means any material which by reason of its action upon, within, or to a person is likely to cause physical harm.

(b) "Lanyard" means a rope, suitable for supporting one person. One end is fastened to a safety belt or harness and the other end is secured to a substantial object or a safety line.

(c) "Lifeline" means a rope, suitable for supporting one person, to which a lanyard or safety belt (or harness) is attached.

(d) "O.D." means optical density and refers to the light refractive characteristics of a lens.

(e) "Radiant energy" means energy that travels outward in all directions from its sources.

(f) "Safety belt" means a device, usually worn around the waist which, by reason of its attachment to a lanyard and lifeline or a structure, will prevent a worker from falling.

**Subpart F—Fire Protection and Prevention [1]**

Sec.

1926.150 Fire protection.
1926.151 Fire prevention.
1926.152 Flammable and combustible liquids.
*1910.106 Flammable and combustible liquids.*
1926.153 Liquefied petroleum gas (LP-Gas).
*1910.110 Storage and handling of LGP's.*
1926.154 Temporary heating devices.
1926.155 Definitions applicable to this subpart.

**§ 1926.150 Fire protection.**

(a) *General requirements.* (1) The employer shall be responsible for the development of a fire protection program to be followed throughout all phases of the construction and demolition work, and he shall provide for the firefighting equipment as specified in this subpart. As fire hazards occur, there shall be no delay in providing the necessary equipment.

(2) Access to all available firefighting equipment shall be maintained at all times.

(3) All firefighting equipment, provided by the employer, shall be conspicuously located.

(4) All firefighting equipment shall be periodically inspected and maintained in operating condition. Defective equipment shall be immediately replaced.

(5) As warranted by the project, the employer shall provide a trained and equipped firefighting organization (Fire Brigade) to assure adequate protection to life.

(b) *Water supply.* (1) A temporary or permanent water supply, of sufficient volume, duration, and pressure, required to properly operate the firefighting equipment shall be made available as soon as combustible materials accumulate.

(2) Where underground water mains are to be provided, they shall be installed, completed, and made available for use as soon as practicable.

(c) *Portable firefighting equipment—*

(1) *Fire extinguishers and small hose lines.* (i) A fire extinguisher, rated not less than 2A, shall be provided for each 3,000 square feet of the protected building area, or major fraction thereof. Travel distance from any point of the protected area to the nearest fire extinguisher shall not exceed 100 feet.

(ii) One 55-gallon open drum of water with two fire pails may be substituted for a fire extinguisher having a 2A rating.

(iii) A ½-inch diameter garden-type hose line, not to exceed 100 feet in length and equipped with a nozzle, may be substituted for a 2A-rated fire extinguisher, providing it is capable of discharging a minimum of 5 gallons per minute with a minimum hose stream range of 30 feet horizontally. The garden-type hose lines shall be mounted on conventional racks or reels. The number and location of hose racks or reels shall be such that at least one hose stream can be applied to all points in the area.

(iv) One or more fire extinguishers, rated not less than 2A, shall be provided on each floor. In multistory buildings, at least one fire extinguisher shall be located adjacent to stairway.

(v) Extinguishers and water drums, subject to freezing, shall be protected from freezing.

(vi) A fire extinguisher, rated not less than 10B, shall be provided within 50 feet of wherever more than 5 gallons of flammable or combustible liquids or 5 pounds of flammable gas are being used on the jobsite. This requirement does not apply to the integral fuel tanks of motor vehicles.

(vii) Carbon tetrachloride and other toxic vaporizing liquid fire extinguishers are prohibited.

(viii) Portable fire extinguishers shall be inspected periodically and maintained in accordance with Maintenance and Use of Portable Fire Extinguishers, NFPA No. 10A-1970.

(ix) Fire extinguishers which have been listed or approved by a nationally recognized testing laboratory, shall be used to meet the requirements of this subpart.

(x) Table F-1 may be used as a guide for selecting the appropriate portable fire extinguishers.

[1] Portions of the listed Part 1910 standards have been identified as applicable to construction.

Table F-1 FIRE EXTINGUISHERS DATA

| | WATER TYPE | | | | FOAM | CARBON DIOXIDE | DRY CHEMICAL | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | SODIUM OR POTASSIUM BICARBONATE | | MULTI-PURPOSE ABC | |
| | STORED PRESSURE | CARTRIDGE OPERATED | WATER PUMP TANK | SODA ACID | FOAM | CO 2 | CARTRIDGE OPERATED | STORED PRESSURE | STORED PRESSURE | CARTRIDGE OPERATED |
| CLASS A FIRES WOOD, PAPER, TRASH HAVING GLOWING EMBERS | YES | YES | YES | YES | YES | NO (BUT WILL CONTROL SMALL SURFACE FIRES) | NO (BUT WILL CONTROL SMALL SURFACE FIRES) | NO (BUT WILL CONTROL SMALL SURFACE FIRES) | YES | YES |
| CLASS B FIRES FLAMMABLE LIQUIDS, GASOLINE, OIL, PAINTS, GREASE, ETC. | NO | NO | NO | NO | YES | YES | YES | YES | YES | YES |
| CLASS C FIRES ELECTRICAL EQUIPMENT | NO | NO | NO | NO | NO | YES | YES | YES | YES | YES |
| CLASS D FIRES COMBUSTIBLE METALS | SPECIAL EXTINGUISHING AGENTS APPROVED BY RECOGNIZED TESTING LABORATORIES | | | | | | | | | |
| METHOD OF OPERATION | PULL PIN—SQUEEZE HANDLE | TURN UPSIDE DOWN AND BUMP | PUMP HANDLE | TURN UPSIDE DOWN | TURN UPSIDE DOWN | PULL PIN—SQUEEZE LEVER | RUPTURE CARTRIDGE—SQUEEZE LEVER | PULL PIN—SQUEEZE HANDLE | PULL PIN—SQUEEZE HANDLE | RUPTURE CARTRIDGE—SQUEEZE LEVER |
| RANGE | 30'-40' | 30'-40' | 30'-40' | 30'-40' | 30'-40' | 3'-8' | 5'-20' | 5'-20' | 5'-20' | 5'-20' |
| MAINTENANCE | CHECK AIR PRESSURE GAUGE MONTHLY | WEIGH GAS CARTRIDGE—ADD WATER IF REQUIRED ANNUALLY | DISCHARGE AND FILL WITH WATER ANNUALLY | DISCHARGE ANNUALLY RECHARGE | DISCHARGE ANNUALLY RECHARGE | WEIGH SEMI-ANNUALLY | WEIGH GAS CARTRIDGE—CHECK CONDITION OF DRY CHEMICAL ANNUALLY | CHECK PRESSURE GAUGE AND CONDITION OF DRY CHEMICAL ANNUALLY | CHECK PRESSURE GAUGE AND CONDITION OF DRY CHEMICAL ANNUALLY | WEIGH GAS CARTRIDGE—CHECK CONDITION OF DRY CHEMICAL ANNUALLY |

(2) *Fire hose and connections.* (i) One hundred feet, or less, of 1½-inch hose, with a nozzle capable of discharging water at 25 gallons or more per minute, may be substituted for a fire extinguisher rated not more than 2A in the designated area provided that the hose line can reach all points in the area.

(ii) If fire hose connections are not compatible with local firefighting equipment, the contractor shall provide adapters, or equivalent, to permit connections.

(iii) During demolition involving combustible materials, charged hose lines, supplied by hydrants, water tank trucks with pumps, or equivalent, shall be made available.

(d) *Fixed firefighting equipment*—(1) *Sprinkler protection.* (i) If the facility being constructed includes the installation of automatic sprinkler protection, the installation shall closely follow the construction and be placed in service as soon as applicable laws permit following completion of each story.

(ii) During demolition or alterations, existing automatic sprinkler installations shall be retained in service as long as reasonable. The operation of sprinkler control valves shall be permitted only by properly authorized persons. Modification of sprinkler systems to permit alterations or additional demolition should be expedited so that the automatic protection may be returned to service as quickly as possible. Sprinkler control valves shall be checked daily at close of work to ascertain that the protection is in service.

(2) *Standpipes.* In all structures in which standpipes are required, or where standpipes exist in structures being altered, they shall be brought up as soon as applicable laws permit, and shall be maintained as construction progresses in such a manner that they are always ready for fire protection use. The standpipes shall be provided with Siamese fire department connections on the outside of the structure, at the street level, which shall be conspicuously marked. There shall be at least one standard hose outlet at each floor.

(e) *Fire alarm devices.* (1) An alarm system, e.g., telephone system, siren, etc., shall be established by the employer whereby employees on the site and the local fire department can be alerted for an emergency.

(2) The alarm code and reporting instructions shall be conspicuously posted at phones and at employee entrances.

(f) *Fire cutoffs.* (1) Fire walls and exit stairways, required for the completed buildings, shall be given construction priority. Fire doors, with automatic closing devices, shall be hung on openings as soon as practicable.

(2) Fire cutoffs shall be retained in buildings undergoing alterations or demolition until operations necessitate their removal.

**§ 1926.151 Fire prevention.**

(a) *Ignition hazards.* (1) Electrical wiring and equipment for light, heat, or power purposes shall be installed in compliance with the requirements of the National Electrical Code, NFPA 70-1971; ANSI C1-1971 (Rev. of 1968), and the requirements of Subpart K of this part.

(2) Internal combustion engine powered equipment shall be so located that the exhausts are well away from combustible materials. When the exhausts are piped to outside the building under construction, a clearance of at least 6 inches shall be maintained between such piping and combustible material.

(3) Smoking shall be prohibited at or in the vicinity of operations which constitute a fire hazard, and shall be conspicuously posted: "No Smoking or Open Flame."

(4) Portable battery powered lighting equipment, used in connection with the storage, handling, or use of flammable gases or liquids, shall be of the type approved for the hazardous locations.

(5) The nozzle of air, inert gas, and steam lines or hoses, when used in the cleaning or ventilation of tanks and vessels that contain hazardous concentrations of flammable gases or vapors, shall be bonded to the tank or vessel shell. Bonding devices shall not be attached or detached in hazardous concentrations of flammable gases or vapors.

(b) *Temporary buildings.* (1) No temporary building shall be erected where it will adversely affect any means of exit.

(2) Temporary buildings, when located within another building or structure, shall be of either noncombustible construction or of combustible construction having a fire resistance of not less than 1 hour.

(3) Temporary buildings, located other than inside another building and not used for the storage, handling, or use of flammable or combustible liquids, flammable gases, explosives, or blasting agents, or similar hazardous occupancies, shall be located at a distance of not less than 10 feet from another building or structure. Groups of temporary buildings, not exceeding 2,000 square feet in aggregate, shall, for the purposes of this part, be considered a single temporary building.

(c) *Open yard storage.* (1) Combustible materials shall be piled with due regard to the stability of piles and in no case higher than 20 feet.

(2) Driveways between and around combustible storage piles shall be at least 15 feet wide and maintained free from accumulation of rubbish, equipment, or other articles or materials. Driveways shall be so spaced that a maximum grid system unit of 50 feet by 150 feet is produced.

(3) The entire storage site shall be kept free from accumulation of unnecessary combustible materials. Weeds and grass shall be kept down and a regular procedure provided for the periodic cleanup of the entire area.

(4) When there is a danger of an underground fire, that land shall not be used for combustible or flammable storage.

(5) Method of piling shall be solid wherever possible and in orderly and regular piles. No combustible material shall be stored outdoors within 10 feet of a building or structure.

(6) Portable fire extinguishing equipment, suitable for the fire hazard involved, shall be provided at convenient, conspicuously accessible locations in the yard area. Portable fire extinguishers, rated not less than 2A, shall be placed so that maximum travel distance to the nearest unit shall not exceed 100 feet.

(d) *Indoor storage.* (1) Storage shall not obstruct, or adversely affect, means of exit.

(2) All materials shall be stored, handled, and piled with due regard to their fire characteristics.

(3) Noncompatible materials, which may create a fire hazard, shall be segregated by a barrier having a fire resistance of at least 1 hour.

(4) Material shall be piled to minimize the spread of fire internally and to permit convenient access for firefighting. Stable piling shall be maintained at all times. Aisle space shall be maintained to safely accommodate the widest vehicle that may be used within the building for firefighting purposes.

(5) Clearance of at least 36 inches shall be maintained between the top level of the stored material and the sprinkler deflectors.

(6) Clearance shall be maintained around lights and heating units to prevent ignition of combustible materials.

(7) A clearance of 24 inches shall be maintained around the path of travel of fire doors unless a barricade is provided, in which case no clearance is needed. Material shall not be stored within 36 inches of a fire door opening.

**§ 1926.152 Flammable and combustible liquids.**

(a) *General requirements.* (1) Only approved containers and portable tanks shall be used for storage and handling of flammable and combustible liquids. Approved metal safety cans shall be used for the handling and use of flammable liquids in quantities greater than one gallon, except that this shall not apply to those flammable liquid materials which are highly viscid (extremely hard to pour), which may be used and handled in original shipping containers. For quantities of one gallon or less, only the original container or approved metal safety cans shall be used for storage, use, and handling of flammable liquids.

(2) Flammable or combustible liquids shall not be stored in areas used for exits, stairways, or normally used for the safe passage of people.

(b) *Indoor storage of flammable and combustible liquids.* (1) No more than 25 gallons of flammable or combustible liquids shall be stored in a room outside of an approved storage cabinet. For storage of liquefied petroleum gas, see § 1926.153.

(2) Quantities of flammable and combustible liquid in excess of 25 gallons shall be stored in an acceptable or approved cabinet meeting the following requirements:

(i) Acceptable wooden storage cabinets shall be constructed in the following manner, or equivalent: The bottom, sides, and top shall be constructed of an exterior grade of plywood at least 1 inch in thickness, which shall not break down or delaminate under standard fire test conditions. All joints shall be rabbeted and shall be fastened in two directions with flathead wood screws. When more than one door is used, there shall be a rabbeted overlap of not less than 1 inch. Steel hinges shall be mounted in such a manner as to not lose their holding capacity due to loosening or burning out of the screws when subjected to fire. Such cabinets shall be painted inside and out with fire retardant paint.

(ii) Approved metal storage cabinets will be acceptable.

(iii) Cabinets shall be labeled in conspicuous lettering, "Flammable—Keep Fire Away."

(3) Not more than 60 gallons of flammable or 120 gallons of combustible liquids shall be stored in any one storage cabinet. Not more than three such cabinets may be located in a single storage area. Quantities in excess of this shall be stored in an inside storage room.

(4)(i) Inside storage rooms shall be constructed to meet the required fire-resistive rating for their use. Such construction shall comply with the test specifications set forth in Standard Methods of Fire Test of Building Construction and Material, NFPA 251-1969.

(ii) Where an automatic extinguishing system is provided, the system shall be designed and installed in an approved manner. Openings to other rooms or buildings shall be provided with noncombustible liquid-tight raised sills or ramps at least 4 inches in height, or the floor in the storage area shall be at least 4 inches below the surrounding floor. Openings shall be provided with approved self-closing fire doors. The room shall be liquid-tight where the walls join the floor. A permissible alternate to the sill or ramp is an open-grated trench, inside of the room, which drains to a safe location. Where other portions of the building or other buildings are exposed, windows shall be protected as set forth in the Standard for Fire Doors and Windows, NFPA No. 80-1970, for Class E or F openings. Wood of at least 1-inch nominal thickness may be used for shelving, racks, dunnage, scuffboards, floor overlay, and similar installations.

(iii) Materials which will react with water and create a fire hazard shall not be stored in the same room with flammable or combustible liquids.

(iv) Storage in inside storage rooms shall comply with Table F-2 following:

TABLE F-2

| Fire protection provided | Fire resistance | Maximum Size | Total allowable quantities gals./sq.ft./floor area |
|---|---|---|---|
| Yes | 2 hrs | 500 sq. ft. | 10 |
| No | 2 hrs | 500 sq. ft. | 4 |
| Yes | 1 hr | 150 sq. ft. | 5 |
| No | 1 hr | 150 sq. ft. | 2 |

NOTE: Fire protection system shall be sprinkler, water spray, carbon dioxide or other system approved by a nationally recognized testing laboratory for this purpose.

(v) Electrical wiring and equipment located in inside storage rooms shall be approved for Class I, Division 1, Hazardous Locations. For definition of Class I, Division 1, Hazardous Locations, see § 1926.404.

(vi) Every inside storage room shall be provided with either a gravity or a mechanical exhausting system. Such system shall commence not more than 12 inches above the floor and be designed to provide for a complete change of air within the room at least 6 times per hour. If a mechanical exhausting system is used, it shall be controlled by a switch located outside of the door. The ventilating equipment and any lighting fixtures shall be operated by the same switch. An electric pilot light shall be installed adjacent to the switch if flammable liquids are dispensed within the room. Where gravity ventilation is provided, the fresh air intake, as well as the exhausting outlet from the room, shall be on the exterior of the building in which the room is located.

(vii) In every inside storage room there shall be maintained one clear aisle at least 3 feet wide. Containers over 30 gallons capacity shall not be stacked one upon the other.

(viii) Flammable and combustible liquids in excess of that permitted in inside storage rooms shall be stored outside of buildings in accordance with paragraph (c) of this section.

(c) *Storage outside buildings.* (1) Storage of containers (not more than 60 gallons each) shall not exceed 1,100 gallons in any one pile or area. Piles or groups of containers shall be separated by a 5-foot clearance. Piles or

groups of containers shall not be nearer than 20 feet to a building.

(2) Within 200 feet of each pile of containers, there shall be a 12-foot-wide access way to permit approach of fire control apparatus.

(3) The storage area shall be graded in a manner to divert possible spills away from buildings or other exposures, or shall be surrounded by a curb or earth dike at least 12 inches high. When curbs or dikes are used, provisions shall be made for draining off accumulations of ground or rain water, or spills of flammable or combustible liquids. Drains shall terminate at a safe location and shall be accessible to operation under fire conditions.

(4) Outdoor portable tank storage: (i) Portable tanks shall not be nearer than 20 feet from any building. Two or more portable tanks, grouped together, having a combined capacity in excess of 2,200 gallons, shall be separated by a 5-foot-clear area. Individual portable tanks exceeding 1,100 gallons shall be separated by a 5-foot-clear area.

(ii) Within 200 feet of each portable tank, there shall be a 12-foot-wide access way to permit approach of fire control apparatus.

(5) Storage areas shall be kept free of weeds, debris, and other combustible material not necessary to the storage.

(6) Portable tanks, not exceeding 660 gallons, shall be provided with emergency venting and other devices, as required by chapters III and IV of NFPA 30-1969, The Flammable and Combustible Liquids Code.

(7) Portable tanks, in excess of 660 gallons, shall have emergency venting and other devices, as required by chapters II and III of The Flammable and Combustible Liquids Code, NFPA 30-1969.

(d) *Fire control for flammable or combustible liquid storage.* (1) At least one portable fire extinguisher, having a rating of not less than 20-B units, shall be located outside of, but not more than 10 feet from, the door opening into any room used for storage of more than 60 gallons of flammable or combustible liquids.

(2) At least one portable fire extinguisher having a rating of not less than 20-B units shall be located not less than 25 feet, nor more than 75 feet, from any flammable liquid storage area located outside.

(3) When sprinklers are provided, they shall be installed in accordance with the Standard for the Installation of Sprinkler Systems, NFPA 13-1969.

(4) At least one portable fire extinguisher having a rating of not less than 20-B:C units shall be provided on all tank trucks or other vehicles used for transporting and/or dispensing flammable or combustible liquids.

(e) *Dispensing liquids.* (1) Areas in which flammable or combustible liquids are transferred at one time, in quantities greater than 5 gallons from one tank or container to another tank or container, shall be separated from other operations by 25-feet distance or by construction having a fire resistance of at least 1 hour. Drainage or other means shall be provided to control spills. Adequate natural or mechanical ventilation shall be provided to maintain the concentration of flammable vapor at or below 10 percent of the lower flammable limit.

(2) Transfer of flammable liquids from one container to another shall be done only when containers are electrically interconnected (bonded).

(3) Flammable or combustible liquids shall be drawn from or transferred into vessels, containers, or tanks within a building or outside only through a closed piping system, from safety cans, by means of a device drawing through the top, or from a container, or portable tanks, by gravity or pump, through an approved self-closing valve. Transferring by means of air pressure on the container or portable tanks is prohibited.

(4) The dispensing units shall be protected against collision damage.

(5) Dispensing devices and nozzles for flammable liquids shall be of an approved type.

(f) *Handling liquids at point of final use.* (1) Flammable liquids shall be kept in closed containers when not actually in use.

(2) Leakage or spillage of flammable or combustible liquids shall be disposed of promptly and safely.

(3) Flammable liquids may be used only where there are no open flames or other sources of ignition within 50 feet of the operation, unless conditions warrant greater clearance.

(g) *Service and refueling areas.* (1) Flammable or combustible liquids shall be stored in approved closed containers, in tanks located underground, or in aboveground portable tanks.

(2) The tank trucks shall comply with the requirements covered in the Standard for Tank Vehicles for Flammable and Combustible Liquids, NFPA No. 385-1966.

(3) The dispensing hose shall be an approved type.

(4) The dispensing nozzle shall be an approved automatic-closing type without a latch-open device.

(5) Underground tanks shall not be abandoned.

(6) Clearly identified and easily accessible switch(es) shall be provided at a location remote from dispensing devices to shut off the power to all dispensing devices in the event of an emergency.

(7)(i) Heating equipment of an approved type may be installed in the lubrication or service area where there is no dispensing or transferring of flammable liquids, provided the bottom of the heating unit is at least 18 inches above the floor and is protected from physical damage.

(ii) Heating equipment installed in lubrication or service areas, where flammable liquids are dispensed, shall be of an approved type for garages, and shall be installed at least 8 feet above the floor.

(8) There shall be no smoking or open flames in the areas used for fueling, servicing fuel systems for internal combustion engines, receiving or dispensing of flammable or combustible liquids.

(9) Conspicuous and legible signs prohibiting smoking shall be posted.

(10) The motors of all equipment being fueled shall be shut off during the fueling operation.

(11) Each service or fueling area shall be provided with at least one fire extinguisher having a rating of not less than 20-B:C located so that an extinguisher will be within 75 feet of each pump, dispenser, underground fill pipe opening, and lubrication or service area.

The following requirements from 29 CFR Part 1910 (General Industry) have been identified as applicable to construction (29 CFR 1926.152 *Flammable and combustible liquids*), in accordance with their respective scope and definitions.

**§ 1910.106 Flammable and combustible liquids.**

* * * * *

(g) *Service stations*—(1) *Storage and handling*—(i) *General provisions.* * * *

(G) Accurate inventory records shall be maintained and reconciled on all class I liquid storage tanks for possible indication of leakage from tanks or piping.

* * * * *

(4) *Marine service stations*—(i) *Dispensing.* (*a*) The dispensing area shall be located away from other structures so as to provide room for safe ingress and egress of craft to be fueled. Dispensing units shall in all cases be at least 20 feet from any activity involving fixed sources of ignition.

(*b*) Dispensing shall be by approved dispensing units with or without integral pumps and may be located on open piers, wharves, or floating docks or on shore or on piers of the solid fill type.

(*c*) Dispensing nozzles shall be automatic-closing without a hold-open latch.

(ii) *Tanks and pumps.* (*a*) Tanks, and pumps not integral with the dispensing unit, shall be on shore or on a pier of the solid fill type, except as provided in subdivision (b) and (c) of this subdivision.

(*b*) Where shore location would require excessively long supply lines to dispensers, tanks may be installed on a pier provided that applicable portions of paragraph (b) of this section relative to spacing, diking, and piping are complied with and the quantity so stored does not exceed 1,100 gallons aggregate capacity.

(*c*) Shore tanks supplying marine service stations may be located above ground, where rock ledges or high water table make underground tanks impractical.

(*d*) Where tanks are at an elevation which would produce gravity head on the dispensing unit, the tank outlet shall be equipped with a pressure control valve positioned adjacent to and outside the tank block valve specified in paragraph (b)(2)(ix)(*b*) of this section, so adjusted that liquid cannot flow by gravity from the tank in case of piping or hose failure.

(iii) *Piping.* (*a*) Piping between shore tanks and dispensing units shall be as described in paragraph (c) of this section, except that, where dispensing is from a floating structure, suitable lengths of oil-resistant flexible hose may be employed between the shore piping and the piping on the floating structure as made necessary by change in water level or shoreline.

(*b*) A readily accessible valve to shut off the supply from shore shall be provided in each pipeline at or near the approach to the pier and at the shore end of each pipeline adjacent to the point where flexible hose is attached.

(*c*) Piping shall be located so as to be protected from physical damage.

(*d*) Piping handling Class I liquids shall be grounded to control stray currents.

* * * * *

(j) *Scope.* This section applies to the handling, storage, and use of flammable and combustible liquids with a flash point below 200° F. This section does not apply to: (1) Bulk transportation of flammable and combustible liquids;

(2) Storage, handling, and use of fuel oil tanks and containers connected with oil burning equipment;

* * * * *

**§ 1910.106 Flammable and combustible liquids.**

(a) *Definitions.* * * *

(22) Marine service station shall mean that portion of a property where flammable or combustible liquids used as fuels are stored and dispensed from fixed equipment on shore, piers, wharves, or floating docks into the fuel tanks of self-propelled craft, and shall include all facilities used in connection therewith.

* * * * *

---

**§ 1926.153 Liquefied petroleum gas (LP-Gas).**

(a) *Approval of equipment and systems.* (1) Each system shall have containers, valves, connectors, manifold valve assemblies, and regulators of an approved type.

(2) All cylinders shall meet the Department of Transportation specification identification requirements published in 49 CFR Part 178, Shipping Container Specifications.

(b) *Welding on LP-Gas containers.* Welding is prohibited on containers.

(c) *Container valves and container accessories.* (1) Valves, fittings, and accessories connected directly to the container, including primary shut off valves, shall have a rated working pressure of at least 250 p.s.i.g. and shall be of material and design suitable for LP-Gas service.

(2) Connections to containers, except safety relief connections, liquid level gauging devices, and plugged openings, shall have shutoff valves located as close to the container as practicable.

(d) *Safety devices.* (1) Every container and every vaporizer shall be provided with one or more approved safety relief valves or devices. These valves shall be arranged to afford free vent to the outer air with discharge not less than 5 feet horizontally away from any opening into a building which is below such discharge.

(2) Shutoff valves shall not be installed between the safety relief device and the container, or the equipment or piping to which the safety relief device is connected, except that a shutoff valve may be used where the arrangement of this valve is such that full required capacity flow through the safety relief device is always afforded.

(3) Container safety relief devices and regulator relief vents shall be located not less than 5 feet in any direction from air openings into sealed combustion system appliances or mechanical ventilation air intakes.

(e) *Dispensing.* (1) Filling of fuel containers for trucks or motor vehicles from bulk storage containers shall be performed not less than 10 feet from the nearest masonry-walled building, or not less than 25 feet from the nearest building or other construction and, in any event, not less than 25 feet from any building opening.

(2) Filling of portable containers or containers mounted on skids from storage containers shall be performed not less than 50 feet from the nearest building.

(f) *Requirements for appliances.* (1) LP-Gas consuming appliances shall be approved types.

(2) Any appliance that was originally manufactured for operation with a gaseous fuel other than LP-Gas, and is in good condition, may be used with LP-Gas only after it is properly converted, adapted, and tested for performance with LP-Gas before the appliance is placed in use.

(g) *Containers and regulating equipment installed outside of buildings or structures.* Containers shall be upright upon firm foundations or otherwise firmly secured. The possible effect on the outlet piping of settling shall be guarded against by a flexible connection or special fitting.

(h) *Containers and equipment used inside of buildings or structures.* (1) When operational requirements make portable use of containers necessary, and their location outside of buildings or structures is impracticable, containers and equipment shall be permitted to be used inside of buildings or structures in accordance with subparagraphs (2) through (11) of this paragraph.

(2) "Containers in use" means connected for use.

(3) Systems utilizing containers having a water capacity greater than 2½ pounds (nominal 1 pound LP-Gas capacity) shall be equipped with excess flow valves. Such excess flow valves shall be either integral with the container valves or in the connections to the container valve outlets.

(4) Regulators shall be either directly connected to the container valves or to manifolds connected to the container valves. The regulator shall be suitable for use with LP-Gas. Manifolds and fittings connecting containers to pressure regulator inlets shall be designed for at least 250 p.s.i.g. service pressure.

(5) Valves on containers having water capacity greater than 50 pounds (nominal 20 pounds LP-Gas capacity) shall be protected from damage while in use or storage.

(6) Aluminum piping or tubing shall not be used.

(7) Hose shall be designed for a working pressure of at least 250 p.s.i.g. Design, construction, and performance of hose, and hose connections shall have their suitability determined by listing by a nationally recognized test-

ing agency. The hose length shall be as short as practicable. Hoses shall be long enough to permit compliance with spacing provisions of subparagraphs (1)–(13) of this paragraph, without kinking or straining, or causing hose to be so close to a burner as to be damaged by heat.

(8) Portable heaters, including salamanders, shall be equipped with an approved automatic device to shut off the flow of gas to the main burner, and pilot if used, in the event of flame failure. Such heaters, having inputs above 50,000 B.t.u. per hour, shall be equipped with either a pilot, which must be lighted and proved before the main burner can be turned on, or an electrical ignition system.

NOTE: The provisions of this subparagraph do not apply to portable heaters under 7,500 B.t.u. per hour input when used with containers having a maximum water capacity of 2½ pounds.

(9) Container valves, connectors, regulators, manifolds, piping, and tubing shall not be used as structural supports for heaters.

(10) Containers, regulating equipment, manifolds, pipe, tubing, and hose shall be located to minimize exposure to high temperatures or physical damage.

(11) Containers having a water capacity greater than 2½ pounds (nominal 1 pound LP-Gas capacity) connected for use shall stand on a firm and substantially level surface and, when necessary, shall be secured in an upright position.

(12) The maximum water capacity of individual containers shall be 245 pounds (nominal 100 pounds LP-Gas capacity).

(13) For temporary heating, heaters (other than integral heater-container units) shall be located at least 6 feet from any LP-Gas container. This shall not prohibit the use of heaters specifically designed for attachment to the container or to a supporting standard, provided they are designed and installed so as to prevent direct or radiant heat application from the heater onto the containers. Blower and radiant type heaters shall not be directed toward any LP-Gas container within 20 feet.

(14) If two or more heater-container units, of either the integral or nonintegral type, are located in an unpartitioned area on the same floor, the container or containers of each unit shall be separated from the container or containers of any other unit by at least 20 feet.

(15) When heaters are connected to containers for use in an unpartitioned area on the same floor, the total water capacity of containers, manifolded together for connection to a heater or heaters, shall not be greater than 735 pounds (nominal 300 pounds LP-Gas capacity). Such manifolds shall be separated by at least 20 feet.

(16) Storage of containers awaiting use shall be in accordance with paragraphs (j) and (k) of this section.

(i) *Multiple container systems.* (1) Valves in the assembly of multiple container systems shall be arranged so that replacement of containers can be made without shutting off the flow of gas in the system. This provision is not to be construed as requiring an automatic changeover device.

(2) Heaters shall be equipped with an approved regulator in the supply line between the fuel cylinder and the heater unit. Cylinder connectors shall be provided with an excess flow valve to minimize the flow of gas in the event the fuel line becomes ruptured.

(3) Regulators and low-pressure relief devices shall be rigidly attached to the cylinder valves, clyinders, supporting standards, the building walls, or otherwise rigidly secured, and shall be so installed or protected from the elements.

(j) *Storage of LPG containers.* Storage of LPG within buildings is prohibited.

(k) *Storage outside of buildings.* (1) Storage outside of buildings, for containers awaiting use, shall be located from the nearest building or group of buildings, in accordance with the following:

TABLE F-3

| Quantity of LP-Gas stored: | Distance (feet) |
|---|---|
| 500 lbs. or less | 0 |
| 501 to 6,000 lbs | 10 |
| 6,001 to 10,000 lbs | 20 |
| Over 10,000 lbs | 25 |

(2) Containers shall be in a suitable ventilated enclosure or otherwise protected against tampering.

(l) *Fire protection.* Storage locations shall be provided with at least one approved portable fire extinguisher having a rating of not less than 20-B:C.

The following requirements from 29 CFR Part 1910 (General Industry) have been identified as applicable to construction (29 CFR 1926.153 *Liquid petroleum gas (LP-gas)*, in accordance with their respective scope and definitions.

**§ 1910.110 Storage and handling of liquefied petroleum gases.**

(a) *Definitions as used in this section.*

(1) API-ASME container—A container constructed in accordance with the requirements of *paragraph (b)(3)(iii) of this section.*

(2) ASME container—A container constructed in accordance with the requirements of *paragraph (b)(3)(i) of this section.*

* * * * *

(4) Containers—All vessels, such as tanks, cylinders of drums, used for transportation or storing liquefied petroleum gases.

---

* * * * *

(b) * * *

(5) * * *

(iii) When LP-Gas and one or more other gases are stored or used in the same area, the containers shall be marked to identify their content. Marking shall be in compliance with American National Standard Z48.1-1954, "Method of Marking Portable Compressed Gas Containers To Identify the Material Contained."

* * * * *

(d) *Systems utilizing containers other than DOT containers*—(1) *Application.* This paragraph applies specifically to systems utilizing storage containers other than those constructed in accordance with DOT specifications. Paragraph (b) of this section applies to this paragraph unless otherwise noted in *paragraph (b) of this section.*

(2) *Design pressure and classification of storage containers.* Storage containers shall be designed and classified in accordance with Table H-31.

TABLE H-31

| Container type | Minimum design pressure of container, lb. per sq. in. gage: For gases with vapor press. Not to exceed lb. per sq. in. gage at 100° F. (37.8° C.) | 1949 and earlier editions of ASME Code (Par. U-68, U-69) | 1949 edition of ASME Code (Par. U-200, U-201); 1950, 1952, 1956, 1959, 1962, 1965, and 1968 (Division I) editions of ASME Code; All editions of API-ASME Code [3] |
|---|---|---|---|
| [1]80 | [1]80 | [1]80 | [1]100 |
| 100 | 100 | 100 | 125 |
| 125 | 125 | 125 | 156 |
| 150 | 150 | 150 | 187 |
| 175 | 175 | 175 | 219 |
| [2]200 | 215 | 200 | 250 |

[1] New storage containers of the 80 type have not been authorized since Dec. 31, 1947.

[2] Container type may be increased by increments of 25. The minimum design pressure of containers shall be 100% of the container type designation when constructed under 1949 or earlier editions of the ASME Code (Par. U-68 and U-69). The minimum design pressure of containers shall be 125% of the container type designation when constructed under: (1) the 1949 ASME Code (Par. U-200 and U-201), (2) 1950, 1952, 1956, 1959, 1962, 1965, and 1968 (Division I) editions of the ASME Code, and (3) all editions of the API-ASME Code.

[3] Construction of containers under the API-ASME Code is not authorized after July 1, 1961.

* * * * *

(7) * * *

(vii) Containers with foundations attached (portable or semiportable containers with suitable steel "runners" or "skids" and popularly known in the industry as "skid tanks") shall be designed, installed, and used in accordance with these rules subject to the following provisions:

(*a*) If they are to be used at a given general location for a temporary period not to exceed 6 months they need not have fire-resisting foundations or saddles but shall have adequate ferrous metal supports.

(*b*) They shall not be located with the outside bottom of the container shell more than 5 feet above the surface of the ground unless fire-resisting supports are provided.

(*c*) The bottom of the skids shall not be less than 2 inches or more than 12 inches below the outside bottom of the container shell.

(*d*) Flanges, nozzles, valves, fittings, and the like, having communication with the interior of the container, shall be protected against physical damage.

(*e*) When not permanently located on fire-resisting foundations, piping connections shall be sufficiently flexible to minimize the possibility of breakage or leakage of connections if the container settles, moves, or is otherwise displaced.

(*f*) Skids, or lugs for attachment of skids, shall be secured to the container in accordance with the code or rules under which the container is designed and built (with a minimum factor of safety of four) to withstand loading in any direction equal to four times the weight of the container and attachments when filled to the maximum permissible loaded weight.

(viii) Field welding where necessary shall be made only on saddle plates or brackets which were applied by the manufacturer of the tank.

* * * * *

(10) *Damage from vehicles.* When damage to LP-Gas systems from vehicular traffic is a possibility, precautions against such damage shall be taken.

* * * * *

**§ 1926.154 Temporary heating devices.**

(a) *Ventilation.* (1) Fresh air shall be supplied in sufficient quantities to maintain the health and safety of workmen. Where natural means of fresh air supply is inadequate, mechanical ventilation shall be provided.

(2) When heaters are used in confined spaces, special care shall be taken to provide sufficient ventilation in order to ensure proper combustion, maintain the health and safety of workmen, and limit temperature rise in the area.

(b) *Clearance and mounting.* (1) Temporary heating devices shall be installed to provide clearance to combustible material not less than the amount shown in Table F–4.

(2) Temporary heating devices, which are listed for installation with lesser clearances than specified in Table F–4, may be installed in accordance with their approval.

TABLE F–4

| Heating appliances | Minimum clearance, (inches) | | |
|---|---|---|---|
| | Sides | Rear | Chimney connector |
| Room heater, circulating type ... | 12 | 12 | 18 |
| Room heater, radiant type..... | 36 | 36 | 18 |

(3) Heaters not suitable for use on wood floors shall not be set directly upon them or other combustible materials. When such heaters are used, they shall rest on suitable heat insulating material or at least 1-inch concrete, or equivalent. The insulating material shall extend beyond the heater 2 feet or more in all directions.

(4) Heaters used in the vicinity of combustible tarpaulins, canvas, or similar coverings shall be located at least 10 feet from the coverings. The coverings shall be securely fastened to prevent ignition or upsetting of the heater due to wind action on the covering or other material.

(c) *Stability.* Heaters, when in use, shall be set horizontally level, unless otherwise permitted by the manufacturer's markings.

(d) *Solid fuel salamanders.* Solid fuel salamanders are prohibited in buildings and on scaffolds.

(e) *Oil-fired heaters.* (1) Flammable liquid-fired heaters shall be equipped with a primary safety control to stop the flow of fuel in the event of flame failure. Barometric or gravity oil feed shall not be considered a primary safety control.

(2) Heaters designed for barometric or gravity oil feed shall be used only with the integral tanks.

(3) [Revoked]

(4) Heaters specifically designed and approved for use with separate supply tanks may be directly connected for gravity feed, or an automatic pump, from a supply tank.

**§ 1926.155 Definitions applicable to this subpart.**

(a) "Approved", for the purpose of this subpart, means equipment that has been listed or approved by a nationally recognized testing laboratory such as Factory Mutual Engineering Corp., or Underwriters' Laboratories, Inc., or Federal agencies such as Bureau of Mines, or U.S. Coast Guard, which issue approvals for such equipment.

(b) "Closed container" means a container so sealed by means of a lid or other device that neither liquid nor vapor will escape from it at ordinary temperatures.

(c) "Combustible liquids" mean any liquid having a flash point at or above 140° F. (60° C.), and below 200° F. (93.4° C.).

(d) "Combustion" means any chemical process that involves oxidation sufficient to produce light or heat.

(e) "Fire brigade" means an organized group of employees that are knowledgeable, trained, and skilled in the safe evacuation of employees during emergency situations and in assisting in fire fighting operations.

(f) "Fire resistance" means so resistant to fire that, for specified time and under conditions of a standard heat intensity, it will not fail structurally and will not permit the side away from the fire to become hotter than a specified temperature. For purposes of this part, fire resistance shall be determined by the Standard Methods of

Fire Tests of Building Construction and Materials, NFPA 251-1969.

(g) "Flammable" means capable of being easily ignited, burning intensely, or having a rapid rate of flame spread.

(h) "Flammable liquids" means any liquid having a flash point below 140° F. and having a vapor pressure not exceeding 40 pounds per square inch (absolute) at 100° F.

(i) "Flash point" of the liquid means the temperature at which it gives off vapor sufficient to form an ignitable mixture with the air near the surface of the liquid or within the vessel used as determined by appropriate test procedure and apparatus as specified below.

(1) The flash point of liquids having a viscosity less than 45 Saybolt Universal Second(s) at 100° F. (37.8° C.) and a flash point below 175° F. (79.4° C.) shall be determined in accordance with the Standard Method of Test for Flash Point by the Tag Closed Tester, ASTM D-56-69.

(2) The flash point of liquids having a viscosity of 45 Saybolt Universal Second(s) or more at 175° F. (79.4° C.) or higher shall be determined in accordance with the Standard Method of Test for Flash Point by the Pensky Martens Closed Tester, ASTM D-93-69.

(j) "Liquefied petroleum gases," "LPG" and "LP Gas" mean and include any material which is composed predominantly of any of the following hydrocarbons, or mixtures of them, such as propane, propylene, butane (normal butane or iso-butane), and butylenes.

(k) "Portable tank" means a closed container having a liquid capacity more than 60 U.S. gallons, and not intended for fixed installation.

(l) "Safety can" means an approved closed container, of not more than 5 gallons capacity, having a flash-arresting screen, spring-closing lid and spout cover and so designed that it will safely relieve internal pressure when subjected to fire exposure.

(m) "Vapor pressure" means the pressure, measured in pounds per square inch (absolute), exerted by a volatile liquid as determined by the "Standard Method of Test for Vapor Pressure of Petroleum Products (Reid Method)." (ASTM D-323-58).

## Subpart G—Signs, Signals, and Barricades

Sec.

1926.200 Accident prevention signs and tags.
1926.201 Signaling
1926.202 Barricades.
1926.203 Definitions applicable to this subpart.

### §1926.200 Accident prevention signs and tags.

(a) *General.* Signs and symbols required by this subpart shall be visible at all times when work is being performed, and shall be removed or covered promptly when the hazards no longer exist.

(b) *Danger signs.* (1) Danger signs (see Figure G-1) shall be used only where an immediate hazard exists.

(2) Danger signs shall have red as the predominating color for the upper panel; black outline on the borders; and a white lower panel for additional sign wording.

(c) *Caution signs.* (1) Caution signs (see Figure G-2) shall be used only to warn against potential hazards or to caution against unsafe practices.

Figure G-1

Figure G-2

(2) Caution signs shall have yellow as the predominating color; black upper panel and borders; yellow lettering of "caution" on the black panel; and the lower yellow panel for additional sign wording. Black lettering shall be used for additional wording.

(d) *Exit signs.* Exit signs, when required, shall be lettered in legible red letters, not less than 6 inches high, on a white field and the principal stroke of the letters shall be at least three-fourths inch in width.

(e) *Safety instruction signs.* Safety instruction signs, when used, shall be white with green upper panel with white letters to convey the principal message. Any additional wording on the sign shall be black letters on the white background.

(f) *Directional signs.* Directional signs, other than automotive traffic signs specified in paragraph (g) of this section, shall be white with a black panel and a white directional symbol. Any additional wording on the sign shall be black letters on the white background.

(g) *Traffic signs.* (1) Construction areas shall be posted with legible traffic signs at points of hazard.

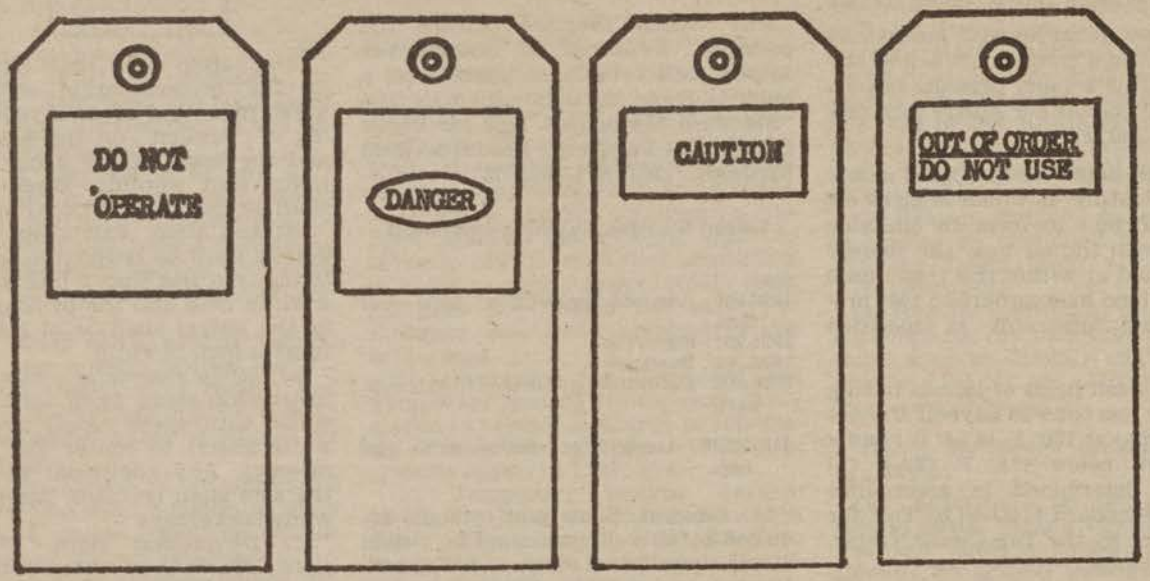
(2) All traffic control signs or devices used for protection of construction workmen shall conform to American National Standards Institute D6.1-1971, Manual on Uniform Traffic Control Devices for Streets and Highways.

(h) *Accident prevention tags.* (1) Accident prevention tags shall be used as a temporary means of warning employees of an existing hazard, such as defective tools, equipment, etc. They shall not be used in place of, or as a substitute for, accident prevention signs.

(2) Specifications for accident prevention tags similar to those in Table G-1 shall apply.

[4510-26-C]

Table G-1




White tag - White letters on red square

White tag - White letters on red oval with a black square

Yellow tag - Yellow letters on a black background

White tag - White letters on black background

| Basic Stock (Background) | Safety Colors (Ink) | Copy Specification (Letters) |
|---|---|---|
| White | Red | Do Not Operate |
| White | Black and Red | Danger |
| Yellow | Black | Caution |
| White | Black | Out of Order<br>Do Not Use |

[4510-26-M]

(i) *Additional rules.* American National Standards Institute (ANSI) Z35.1-1968, Specifications for Accident Prevention Signs, and Z35.2-1968, Specifications for Accident Prevention Tags, contain rules which are additional to the rules prescribed in this section. The employer shall comply with ANSI Z35.1-1968 and Z35.2-1968 with respect to rules not specifically prescribed in this subpart.

**§ 1926.201 Signaling.**

(a) *Flagmen.* (1) When operations are such that signs, signals, and barricades do not provide the necessary protection on or adjacent to a highway or street, flagmen or other appropriate traffic controls shall be provided.

(2) Signaling directions by flagmen shall conform to American National Standards Institute D6.1-1971, Manual on Uniform Traffic Control Devices for Streets and Highways.

(3) Hand signaling by flagmen shall be by use of red flags at least 18 inches square or sign paddles, and in periods of darkness, red lights.

(4) Flagmen shall be provided with and shall wear a red or orange warning garment while flagging. Warning garments worn at night shall be of reflectorized material.

(b) *Crane and hoist signals.* Regulations for crane and hoist signaling will be found in applicable American National Standards Institute standards.

**§ 1926.202 Barricades.**

Barricades for protection of employees shall conform to the portions of the American National Standards Institute D6.1-1971, Manual on Uniform Traffic Control Devices for Streets and Highways, relating to barricades.

**§ 1926.203 Definitions applicable to this Subpart.**

(a) "Barricade" means an obstruction to deter the passage of persons or vehicles.

(b) "Signs" are the warnings of hazard, temporarily or permanently affixed or placed, at locations where hazards exist.

(c) "Signals" are moving signs, provided by workers, such as flagmen, or by devices, such as flashing lights, to warn of possible or existing hazards.

(d) "Tags" are temporary signs, usually attached to a piece of equipment or part of a structure, to warn of existing or immediate hazards.

**Subpart H—Materials Handling, Storage, Use, and Disposal [1]**

Sec.

1926.250 General requirements for storage.
*1910.30 Other working surfaces.*
*1910.176 Handling materials—general.*
1926.251 Rigging equipment for material handling.
*1910.184 Slings.*
1926.252 Disposal of waste materials.

[1] Portions of the listed Part 1910 standards have been identified as applicable to construction.

(a) *General.* (1) All materials stored in tiers shall be stacked, racked, blocked, interlocked, or otherwise secured to prevent sliding, falling or collapse.

(2) Maximum safe load limits of floors within buildings and structures, in pounds per square foot, shall be conspicuously posted in all storage areas, except for floor or slab on grade. Maximum safe loads shall not be exceeded.

(3) Aisles and passageways shall be kept clear to provide for the free and safe movement of material handling equipment or employees. Such areas shall be kept in good repair.

(4) When a difference in road or working levels exist, means such as ramps, blocking, or grading shall be used to ensure the safe movement of vehicles between the two levels.

(b) *Material storage.* (1) Material stored inside buildings under construction shall not be placed within 6 feet of any hoistway or inside floor openings, nor within 10 feet of an exterior wall which does not extend above the top of the material stored.

(2) Employees required to work on stored material in silos, hoppers, tanks, and similar storage areas shall be equipped with lifelines and safety belts meeting the requirements of Subpart E of this part.

(3) Noncompatible materials shall be segregated in storage.

(4) Bagged materials shall be stacked by stepping back the layers and cross-keying the bags at least every 10 bags high.

(5) Materials shall not be stored on scaffolds or runways in excess of supplies needed for immediate operations.

(6) Brick stacks shall not be more than 7 feet in height. When a loose brick stack reaches a height of 4 feet, it shall be tapered back 2 inches in every foot of height above the 4-foot level.

(7) When masonry blocks are stacked higher than 6 feet, the stack shall be tapered back one-half block per tier above the 6-foot level.

(8) Lumber:

(i) Used lumber shall have all nails withdrawn before stacking.

(ii) Lumber shall be stacked on level and solidly supported sills.

(iii) Lumber shall be so stacked as to be stable and self-supporting.

(iv) Lumber piles shall not exceed 20 feet in height provided that lumber to be handled manually shall not be stacked more than 16 feet high.

(9) Structural steel, poles, pipe, bar stock, and other cylindrical materials, unless racked, shall be stacked and blocked so as to prevent spreading or tilting.

The following requirements from 29 CFR Part 1910 (General Industry) have been identified as applicable to construction (29 CFR 1926.250 *General Requirements for Storage*).

**§ 1910.30 Other working surfaces.**

(a) *Dockboards (bridge plates.).* (1) Portable and powered dockboards shall be strong enough to carry the load imposed on them.

(2) Portable dockboards shall be secured in position, either by being anchored or equipped with devices which will prevent their slipping.

* * * * *

(4) Handholds, or other effective means, shall be provided on portable dockboards to permit safe handling.

(5) Positive protection shall be provided to prevent railroad cars from being moved while dockboards or bridge plates are in position.

* * * * *

**§ 1910.176 Handling materials—General.**

* * * * *

(c) *Housingkeeping.* Storage areas shall be kept free from accumulation of materials that constitute hazards from tripping, fire, explosion, or pest harborage. Vegetation control will be exercised when necessary.

---

**§ 1926.251 Rigging equipment for material handling.**

(a) *General.* (1) Rigging equipment for material handling shall be inspected prior to use on each shift and as necessary during its use to ensure that it is safe. Defective rigging equipment shall be removed from service.

(2) Rigging equipment shall not be loaded in excess of its recommended safe working load, as prescribed in Tables H-1 through H-20 in this subpart, following § 1926.252(e) for the specific equipment.

(3) Rigging equipment, when not in use, shall be removed from the immediate work area so as not to present a hazard to employees.

(4) Special custom design grabs, hooks, clamps, or other lifting accessories, for such units as modular panels, prefabricated structures and similar materials, shall be marked to indicate the safe working loads and shall be

proof-tested prior to use to 125 percent of their rated load.

(b) *Alloy steel chains.* (1) Welded alloy steel chain slings shall have permanently affixed durable identification stating size, grade, rated capacity, and sling manufacturer.

(2) Hooks, rings, oblong links, pear-shaped links, welded or mechanical coupling links, or other attachments, when used with alloy steel chains, shall have a rated capacity at least equal to that of the chain.

(3) Job or shop hooks and links, or makeshift fasteners, formed from bolts, rods, etc., or other such attachments, shall not be used.

(4) Rated capacity (working load limit) for alloy steel chain slings shall conform to the values shown in Table H-1.

(5) Whenever wear at any point of any chain link exceeds that shown in Table H-2, the assembly shall be removed from service.

(c) *Wire rope.* (1) Tables H-3 through H-14 shall be used to determine the safe working loads of various sizes and classifications of improved plow steel wire rope and wire rope slings with various types of terminals. For sizes, classifications, and grades not included in these tables, the safe working load recommended by the manufacturer for specific, identifiable products shall be followed, provided that a safety factor of not less than 5 is maintained.

(2) Protruding ends of strands in splices on slings and bridles shall be covered or blunted.

(3) Wire rope shall not be secured by knots, except on haul back lines on scrapers.

(4) The following limitations shall apply to the use of wire rope:

(i) An eye splice made in any wire rope shall have not less than three full tucks. However, this requirement shall not operate to preclude the use of another form of splice or connection which can be shown to be as efficient and which is not otherwise prohibited.

(ii) Except for eye splices in the ends of wires and for endless rope slings, each wire rope used in hoisting or lowering, or in pulling loads, shall consist of one continuous piece without knot or splice.

(iii) Eyes in wire rope bridles, slings, or bull wires shall not be formed by wire rope clips or knots.

(iv) Wire rope shall not be used if, in any length of eight diameters, the total number of visible broken wires exceeds 10 percent of the total number of wires, or if the rope shows other signs of excessive wear, corrosion, or defect.

(5) When U-bolt wire rope clips are used to form eyes, Table H-20 shall be used to determine the number and spacing of clips.

(i) When used for eye splices, the U-bolt shall be applied so that the "U" section is in contact with the dead end of the rope.

(d) *Natural rope, and synthetic fiber*—(1) *General.* When using natural or synthetic fiber rope slings, Tables H-15, 16, 17, and 18 shall apply.

(2) All splices in rope slings provided by the employer shall be made in accordance with fiber rope manufacturers recommendations.

(i) In manila rope, eye splices shall contain at least three full tucks, and short splices shall contain at least six full tucks (three on each side of the centerline of the splice).

(ii) In layed synthetic fiber rope, eye splices shall contain at least four full tucks, and short splices shall contain at least eight full tucks (four on each side of the centerline of the splice).

(iii) Strand end tails shall not be trimmed short (flush with the surface of the rope) immediately adjacent to the full tucks. This precaution applies to both eye and short splices and all types of fiber rope. For fiber ropes under 1-inch diameter, the tails shall project at least six rope diameters beyond the last full tuck. For fiber ropes 1-inch diameter and larger, the tails shall project at least 6 inches beyond the last full tuck. In applications where the projecting tails may be objectionable, the tails shall be tapered and spliced into the body of the rope using at least two additional tucks (which will require a tail length of approximately six rope diameters beyond the last full tuck).

(iv) For all eye splices, the eye shall be sufficiently large to provide an included angle of not greater than 60° at the splice when the eye is placed over the load or support.

(v) Knots shall not be used in lieu of splices.

(e) *Synthetic webbing (nylon, polyester, and polypropylene).* (1) The employer shall have each synthetic web sling marked or coded to show:

(i) Name or trademark of manufacturer.

(ii) Rated capacities for the type of hitch.

(iii) Type of material.

(2) Rated capacity shall not be exceeded.

(f) *Shackles and hooks.* (1) Table H-19 shall be used to determine the safe working loads of various sizes of shackles, except that higher safe working loads are permissible when recommended by the manufacturer for specific, identifiable products, provided that a safety factor of not less than 5 is maintained.

(2) The manufacturer's recommendations shall be followed in determining the safe working loads of the various sizes and types of specific and identifiable hooks. All hooks for which no applicable manufacturer's recommendations are available shall be tested to twice the intended safe working load before they are initially put into use. The employer shall maintain a record of the dates and results of such tests.

The following requirements from 29 CFR Part 1910 (General Industry) have been identified as applicable to construction (29 CFR 1926.251(b), (c), (d) and (e) *Rigging Equipment for material handling*), in accordance with the scope noted below.

For 1926.251(b):

§ 1910.184 Slings.

* * * * *

(e) *Alloy steel chain slings.* * * *

(3) *Inspections.* (i) In addition to the inspection required by paragraph (d) of this section, a thorough periodic inspection of alloy steel chain slings in use shall be made on a regular basis, to be determined on the basis of—

(*a*) frequency of sling use;

(*b*) severity of service conditions;

(*c*) nature of lifts being made; and

(*D*) experience gained on the service life of slings used in similar circumstances. Such inspections shall in no event be at intervals greater than once every 12 months.

(ii) The employer shall make and maintain a record of the most recent month in which each alloy steel chain sling was thoroughly inspected, and shall make such record available for examination.

* * * * *

For 1926.251(c):

§ 1910.184 Slings.

* * * * *

(c) *Safe operating practices.* Whenever any sling is used, the following practices shall be observed. * * *

(2) Slings shall not be shortened with knots or bolts or other makeshift devices.

(3) Sling legs shall not be kinked.

(5) Slings used in a basket hitch shall have the loads balanced to prevent slippage.

* * * * *

(7) Slings shall be padded or protected from the sharp edges of their loads.

* * * * *

(10) Hands or fingers shall not be placed between the sling and its load while the sling is being tightened around the load.

(11) Shock loading is prohibited.

(12) A sling shall not be pulled from under a load when the load is resting on the sling.

* * * * *

(f) *Were rope slings.* * * *

(2) *Minimum sling lengths.* (i) Cable laid and 6 × 19 and 6 × 37 slings shall have a minimum clear length of wire rope 10 times the component rope diameter between splices, sleeves or end fittings.

(ii) Braided slings shall have a minimum clear length of wore rope 40 times the component rope diameter between the loops or end fittings.

(iii) Cable laid grommets, strand laid grommets and endless slings shall have a minimum circumferential length of 96 times their body diameter.

(3) *Safe operating temperatures.* Fiber core wire rope slings of all grades shall be permanently removed from service if they are exposed to temperatres in excess of 200° F. When nonfiber core wire rope slings of any grade are used at temperatures above 400° F or below minus 60° F, recommendations of the sling manufacturer regarding use at that temperature shall be followed.

(4) *End attachments.* (i) Welding of end attachments, except covers to thimbles, shall be performed prior to the assembly of the sling.

(ii) All welded end attachments shall not be used unless proof tested by the manufacturer or equivalent entity at twice their rated capacity prior to initial use. The employer shall retain a certificate of the proof test, and make it available for examination.

For 1926.251(d):

**§ 1910.184 Slings.**

* * * * *

(h) *Natural and synthetic fiber rope slings.* * * *

(2) *Safe operating temperatures.* Natural and synthetic fiber rope slings, except for wet frozen slings, may be used in a temperature range from minus 20° F to plus 180° F without decreasing the working load limit. For operations outside this temperature range and for wet frozen slings, the sling manufacturer's recommendations shall be followed.

(3) *Splicing.* Spliced fiber rope slings shall not be used unless they have been spliced in accordance with the following minimum requirements and in accordance with any additional recommendations of the manufacturer: * * *

(iv) Fiber rope slings shall have a minimum clear length of rope between eye splices equal to 10 times the rope diameter.

(vi) Clamps not designed specifically for fiber ropes shall not be used for splicing.

(4) *End attachments.* Fiber rope slings shall not be used if end attachments in contact with rope have sharp edges or projections.

(5) *Removal from service.* Natural and synthetic fiber rope sling shall be immediately removed from service if any of the following conditions are present:

(i) Abnormal wear.

(ii) Powdered fiber between strands.

(iii) Broken or cut fibers.

(iv) Variations in the size or roundness of strands.

(v) Discoloration or rotting.

(vi) Distortion of hardware in the sling.

For 1926.251(e):

**§ 1910.184 Slings.**

* * * * *

(i) *Synthetic web slings.* * * *

(2) *Webbing.* Synthetic webbing shall be of uniform thickness and width and selvage edges shall not be split from the webbing's width.

(3) *Fittings.* Fittings shall be:

(A) Of a minimum breaking strength equal to that of the sling; and

(B) Free of all sharp edges that could in any way damage the webbing.

(4) *Attachment of end fittings to webbing and formation of eyes.* Stitching shall be the only method used to attach end fittings to webbing and to form eyes. The thread shall be in an even pattern and contain a sufficient number of stitches to develop the full breaking strength of the sling.

* * * * *

(6) *Environmental conditions.* When synthetic web slings are used, the following precautions shall be taken:

(i) Nylon web slings shall not be used where fumes, vapors, sprays, mists or liquids of acids or phenolics are present.

(ii) Polyester and polypropylene web slings shall not be used where fumes, vapors, sprays, mists or liquids of caustics are present.

(iii) Web slings with aluminum fittings shall not be used where fumes, vapors, sprays, mists or liquids of caustics are present.

(7) *Safe operating temperatures.* Synthetic web slings of polyester and nylon shall not be used at temperatures in excess of 180° F. Polypropylene web slings shall not be used at temperatures in excess of 200° F.

* * * * *

(9) *Removal from service.* Synthetic web slings shall be immediately removed from service if any of the following conditions are present:

(i) Acid or caustic burns;

(ii) Melting or charring of any part of the sling surface;

(iii) Snags, punctures, tears or cuts;

(iv) Broken or worn stitches; or

(v) Distortion of fittings.

* * * * *

**§ 1910.184 Slings.**

(a) *Scope.* This section applies to slings used in conjunction with other material handling equipment for the movement of material by hoisting, in employments covered by this Part. The types of slings covered are those made from alloy steel chain, wire rope, metal mesh, natural or synthetic fiber rope (conventional three strand construction), and synthetic web (Nylon, polyester, and polypropylene).

---

**§ 1926.252 Disposal of waste materials.**

(a) Whenever materials are dropped more than 20 feet to any point lying outside the exterior walls of the building, an enclosed chute of wood, or equivalent material, shall be used. For the purpose of this paragraph, an enclosed chute is a slide, closed in on all sides, through which material is moved from a high place to a lower one.

(b) When debris is dropped through holes in the floor without the use of chutes, the area onto which the material is dropped shall be completely enclosed with barricades not less than 42 inches high and not less than 6 feet back from the projected edge of the opening above. Signs warning of the hazard of falling materials shall be posted at each level. Removal shall not be permitted in this lower area until debris handling ceases above.

(c) All scrap lumber, waste material, and rubbish shall be removed from the immediate work area as the work progresses.

(d) Disposal of waste material or debris by burning shall comply with local fire regulations.

(e) All solvent waste, oily rags, and flammable liquids shall be kept in fire resistant covered containers until removed from worksite.

[4510–26–C]

Table H-1
RATED CAPACITY (WORKING LOAD LIMIT), FOR ALLOY STEEL CHAIN SLINGS*
RATED CAPACITY (WORKING LOAD LIMIT), POUNDS

| Chain Size, Inches | Single Branch Sling — 90 degree Loading | Double Sling Vertical Angle (1) 30 degree | 45 degree | 60 degree | Triple and Quadruple Sling Vertical Angle (1) 30 degree | 45 degree | 60 degree |
|---|---|---|---|---|---|---|---|
| | | Horizontal Angle (2) 60 degree | 45 degree | 30 degree | 60 degree | 45 degree | 30 degree |
| 1/4 | 3,250 | 5,560 | 4,550 | 3,250 | 8,400 | 6,800 | 4,900 |
| 3/8 | 6,600 | 11,400 | 9,300 | 6,600 | 17,000 | 14,000 | 9,900 |
| 1/2 | 11,250 | 19,500 | 15,900 | 11,250 | 29,000 | 24,000 | 17,000 |
| 5/8 | 16,500 | 28,500 | 23,300 | 16,500 | 43,000 | 35,000 | 24,500 |
| 3/4 | 23,000 | 39,800 | 32,500 | 23,000 | 59,500 | 48,500 | 34,500 |
| 7/8 | 28,750 | 49,800 | 40,600 | 28,750 | 74,500 | 61,000 | 43,000 |
| 1 | 38,750 | 67,100 | 54,800 | 38,750 | 101,000 | 82,000 | 58,000 |
| 1-1/8 | 44,500 | 77,000 | 63,000 | 44,500 | 115,500 | 94,500 | 66,500 |
| 1-1/4 | 57,500 | 99,500 | 81,000 | 57,500 | 149,000 | 121,500 | 86,000 |
| 1-3/8 | 67,000 | 116,000 | 94,000 | 67,000 | 174,000 | 141,000 | 100,500 |
| 1-1/2 | 80,000 | 138,000 | 112,500 | 80,000 | 207,000 | 169,000 | 119,500 |
| 1-3/4 | 100,000 | 172,000 | 140,000 | 100,000 | 258,000 | 210,000 | 150,000 |

(1) Rating of multileg slings adjusted for angle of loading measured as the included angle between the inclined leg and the vertical.

(2) Rating of multileg slings adjusted for angle of loading between the inclined leg and the horizontal plane of the load.

*Other grades of proof tested steel chain include Proof Coil, BBB Coil and Hi-Test Chain. These grades are not recommended for overhead lifting and therefore are not covered by this code.

---

TABLE H-2—MAXIMUM ALLOWABLE WEAR AT ANY POINT OF LINK

| *Chain size (inches)* | *Maximum allowable wear (inch)* | *Chain size (inches)* | *Maximum allowable wear (inch)* |
|---|---|---|---|
| 1/4 | 3/64 | 1 | 3/16 |
| 3/8 | 5/64 | 1 1/8 | 7/32 |
| 1/2 | 7/64 | 1 1/4 | 1/4 |
| 5/8 | 9/64 | 1 3/8 | 9/32 |
| 3/4 | 5/32 | 1 1/2 | 5/16 |
| 7/8 | 11/64 | 1 3/4 | 11/32 |

TABLE H-3—RATED CAPACITIES FOR SINGLE LEG SLINGS
6×19 and 6×37 Classification Improved Plow Steel Grade Rope with Fiber Core (FC)

| Rope Dia (Inches) | Rope Constr. | Rated Capacities, Tons (2,000 lb.) Vertical HT | Vertical MS | Vertical S | Choker HT | Choker MS | Choker S | Vertical Basket* HT | Vertical Basket* MS | Vertical Basket* S |
|---|---|---|---|---|---|---|---|---|---|---|
| ¼ | 6×19 | 0.49 | 0.51 | 0.55 | 0.37 | 0.38 | 0.41 | 0.99 | 1.0 | 1.1 |
| 5/16 | 6×19 | 0.76 | 0.79 | 0.85 | 0.57 | 0.59 | 0.64 | 1.5 | 1.6 | 1.7 |
| ⅜ | 6×19 | 1.1 | 1.1 | 1.2 | 0.80 | 0.85 | 0.91 | 2.1 | 2.2 | 2.4 |
| 7/16 | 6×19 | 1.4 | 1.5 | 1.6 | 1.1 | 1.1 | 1.2 | 2.9 | 3.0 | 3.3 |
| ½ | 6×19 | 1.8 | 2.0 | 2.1 | 1.4 | 1.5 | 1.6 | 3.7 | 3.9 | 4.3 |
| 9/16 | 6×19 | 2.3 | 2.5 | 2.7 | 1.7 | 1.9 | 2.0 | 4.6 | 5.0 | 5.4 |
| ⅝ | 6×19 | 2.8 | 3.1 | 3.3 | 2.1 | 2.3 | 2.5 | 5.6 | 6.2 | 6.7 |
| ¾ | 6×19 | 3.9 | 4.4 | 4.8 | 2.9 | 3.3 | 3.6 | 7.8 | 8.8 | 9.5 |
| ⅞ | 6×19 | 5.1 | 5.9 | 6.4 | 3.9 | 4.5 | 4.8 | 10.0 | 12.0 | 13.0 |
| 1 | 6×19 | 6.7 | 7.7 | 8.4 | 5.0 | 5.8 | 6.3 | 13.0 | 15.0 | 17.0 |
| 1⅛ | 6×19 | 8.4 | 9.5 | 10.0 | 6.3 | 7.1 | 7.9 | 17.0 | 19.0 | 21.0 |
| 1¼ | 6×37 | 9.8 | 11.0 | 12.0 | 7.4 | 8.3 | 9.2 | 20.0 | 22.0 | 25.0 |
| 1⅜ | 6×37 | 12.0 | 13.0 | 15.0 | 8.9 | 10.0 | 11.0 | 24.0 | 27.0 | 30.0 |
| 1½ | 6×37 | 14.0 | 16.0 | 17.0 | 10.0 | 12.0 | 13.0 | 28.0 | 32.0 | 35.0 |
| 1⅝ | 6×37 | 16.0 | 18.0 | 21.0 | 12.0 | 14.0 | 15.0 | 33.0 | 37.0 | 41.0 |
| 1¾ | 6×37 | 19.0 | 21.0 | 24.0 | 14.0 | 16.0 | 18.0 | 38.0 | 43.0 | 48.0 |
| 2 | 6×37 | 25.0 | 28.0 | 31.0 | 18.0 | 21.0 | 23.0 | 49.0 | 55.0 | 62.0 |

*These values only apply when the D/d ratio for HT slings is 10 or greater, and for MS and S Slings is 20 or greater where:
D=Diameter of curvature around which the body of the sling is bent.
d=Diameter of rope.

HT=Hand Tucked Splice and Hidden Tuck Splice. For hidden tuck splice (IWRC) use values in HT columns.
MS=Mechanical Splice.
S=Swaged or Zinc Poured Socket.

TABLE H-4—RATED CAPACITIES FOR SINGLE LEG SLINGS
6×19 AND 6×37 CLASSIFICATION IMPROVED PLOW STEEL GRADE ROPE WITH INDEPENDENT WIRE ROPE CORE (IWRC)

| Rope Dia. (Inches) | Rope Constr. | Rated Capacities, Tons (2,000 lb.) Vertical HT | Vertical MS | Vertical S | Choker HT | Choker MS | Choker S | Vertical Basket* HT | Vertical Basket* MS | Vertical Basket* S |
|---|---|---|---|---|---|---|---|---|---|---|
| ¼ | 6×19 | 0.53 | 0.56 | 0.59 | 0.40 | 0.42 | 0.44 | 1.0 | 1.1 | 1.2 |
| 5/16 | 6×19 | 0.81 | 0.87 | 0.92 | 0.61 | 0.65 | 0.69 | 1.6 | 1.7 | 1.8 |
| ⅜ | 6×19 | 1.1 | 1.2 | 1.3 | 0.86 | 0.93 | 0.98 | 2.3 | 2.5 | 2.6 |
| 7/16 | 6×19 | 1.5 | 1.7 | 1.8 | 1.2 | 1.3 | 1.3 | 3.1 | 3.4 | 3.5 |
| ½ | 6×19 | 2.0 | 2.2 | 2.3 | 1.5 | 1.6 | 1.7 | 3.9 | 4.4 | 4.6 |
| 9/16 | 6×19 | 2.5 | 2.7 | 2.9 | 1.8 | 2.1 | 2.2 | 4.9 | 5.5 | 5.8 |
| ⅝ | 6×19 | 3.0 | 3.4 | 3.6 | 2.2 | 2.5 | 2.7 | 6.0 | 6.8 | 7.2 |
| ¾ | 6×19 | 4.2 | 4.9 | 5.1 | 3.1 | 3.6 | 3.8 | 8.4 | 9.7 | 10.0 |
| ⅞ | 6×19 | 5.5 | 6.6 | 6.9 | 4.1 | 4.9 | 5.2 | 11.0 | 13.0 | 14.0 |
| 1 | 6×19 | 7.2 | 8.5 | 9.0 | 5.4 | 6.4 | 6.7 | 14.0 | 17.0 | 18.0 |
| 1⅛ | 6×19 | 9.0 | 10.0 | 11.0 | 6.8 | 7.8 | 8.5 | 18.0 | 21.0 | 23.0 |
| 1¼ | 6×37 | 10.0 | 12.0 | 13.0 | 7.9 | 9.2 | 9.9 | 21.0 | 24.0 | 26.0 |
| 1⅜ | 6×37 | 13.0 | 15.0 | 16.0 | 9.6 | 11.0 | 12.0 | 25.0 | 29.0 | 32.0 |
| 1½ | 6×37 | 15.0 | 17.0 | 19.0 | 11.0 | 13.0 | 14.0 | 30.0 | 35.0 | 38.0 |
| 1⅝ | 6×37 | 18.0 | 20.0 | 22.0 | 13.0 | 15.0 | 17.0 | 35.0 | 41.0 | 44.0 |
| 1¾ | 6×37 | 20.0 | 24.0 | 26.0 | 15.0 | 18.0 | 19.0 | 41.0 | 47.0 | 51.0 |
| 2 | 6×37 | 26.0 | 30.0 | 33.0 | 20.0 | 23.0 | 25.0 | 53.0 | 61.0 | 66.0 |

*These values only apply when the D/d ratio for HT slings is 10 or greater, and for MS and S Slings is 20 or greater where:
D=Diameter of curvature around which the body of the sling is bent.
d=Diameter of rope.

HT=Hand Tucked Splice: For hidden tuck splice (IWRC) use Table H-3 values in HT column.
MS=Mechanical Splice.
S=Swaged or Zinc Poured Socket.

TABLE H-5—RATED CAPACITIES FOR SINGLE LEG SLINGS
Cable Laid Rope—Mechanical Splice Only
7×7×7 AND 7×7×19 Constructions Galvanized Aircraft Grade Rope
7×6×19 IWRC Construction Improved Plow Steel Grade Rope

| Rope | | Rated Capacities, Tons (2,000 lb) | | |
|---|---|---|---|---|
| Dia. (Inches) | Constr. | Vertical | Choker | Vert. Basket* |
| ¼ | 7×7×7 | 0.50 | 0.38 | 1.0 |
| ⅜ | 7×7×7 | 1.1 | 0.81 | 2.2 |
| ½ | 7×7×7 | 1.8 | 1.4 | 3.7 |
| ⅝ | 7×7×7 | 2.8 | 2.1 | 5.5 |
| ¾ | 7×7×7 | 3.8 | 2.9 | 7.6 |
| ⅝ | 7×7×19 | 2.9 | 2.2 | 5.8 |
| ¾ | 7×7×19 | 4.1 | 3.0 | 8.1 |
| ⅞ | 7×7×19 | 5.4 | 4.0 | 11.0 |
| 1 | 7×7×19 | 6.9 | 5.1 | 14.0 |
| 1⅛ | 7×7×19 | 8.2 | 6.2 | 16.0 |
| 1¼ | 7×7×19 | 9.9 | 7.4 | 20.0 |
| ¾ | 7×6×19 IWRC | 3.8 | 2.8 | 7.6 |
| ⅞ | 7×6×19 IWRC | 5.0 | 3.8 | 10.0 |
| 1 | 7×6×19 IWRC | 6.4 | 4.8 | 13.0 |
| 1⅛ | 7×6×19 IWRC | 7.7 | 5.8 | 15.0 |
| 1¼ | 7×6×19 IWRC | 9.2 | 6.9 | 18.0 |
| 1⅜ | 7×6×19 IWRC | 10.0 | 7.5 | 20.0 |
| 1⅜ | 7×6×19 IWRC | 11.0 | 8.2 | 22.0 |
| 1½ | 7×6×19 IWRC | 13.0 | 9.6 | 26.0 |

*These values only apply when the D/d ratio in 10 or greater where:
D = Diameter of curvature around which the body of the sling is bent.
d = Diameter of rope.

## Table H-6
## RATED CAPACITIES FOR SINGLE LEG SLINGS
## 8-PART AND 6-PART BRAIDED ROPE
## 6 x 7 AND 6 x 19 CONSTRUCTION IMPROVED PLOW STEEL GRADE ROPE
## 7 x 7 CONSTRUCTION GALVANIZED AIRCRAFT GRADE ROPE

| Component Ropes | | Rated Capacities, Tons (2,000 lb) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Vertical | | Choker | | Basket Vertical to 30 degree* | |
| Diameter (Inches) | Constr | 8-Part | 6-Part | 8-Part | 6-Part | 8-Part | 6-Part |
| 3/32 | 6 x 7 | 0.42 | 0.32 | 0.32 | 0.24 | 0.74 | 0.55 |
| 1/8 | 6 x 7 | 0.76 | 0.57 | 0.57 | 0.42 | 1.3 | 0.98 |
| 3/16 | 6 x 7 | 1.7 | 1.3 | 1.3 | 0.94 | 2.9 | 2.2 |
| 3/32 | 7 x 7 | 0.51 | 0.39 | 0.38 | 0.29 | 0.89 | 0.67 |
| 1/8 | 7 x 7 | 0.95 | 0.71 | 0.71 | 0.53 | 1.6 | 1.2 |
| 3/16 | 7 x 7 | 2.1 | 1.5 | 1.5 | 1.2 | 3.6 | 2.7 |
| 3/16 | 6 x 19 | 1.7 | 1.3 | 1.3 | 0.98 | 3.0 | 2.2 |
| 1/4 | 6 x 19 | 3.1 | 2.3 | 2.3 | 1.7 | 5.3 | 4.0 |
| 5/16 | 6 x 19 | 4.8 | 3.6 | 3.6 | 2.7 | 8.3 | 6.2 |
| 3/8 | 6 x 19 | 6.8 | 5.1 | 5.1 | 3.8 | 12.0 | 8.9 |
| 7/16 | 6 x 19 | 9.3 | 6.9 | 6.9 | 5.2 | 16.0 | 12.0 |
| 1/2 | 6 x 19 | 12.0 | 9.0 | 9.0 | 6.7 | 21.0 | 15.0 |
| 9/16 | 6 x 19 | 15.0 | 11.0 | 11.0 | 8.5 | 26.0 | 20.0 |
| 5/8 | 6 x 19 | 19.0 | 14.0 | 14.0 | 10.0 | 32.0 | 24.0 |
| 3/4 | 6 x 19 | 27.0 | 20.0 | 20.0 | 15.0 | 46.0 | 35.0 |
| 7/8 | 6 x 19 | 36.0 | 27.0 | 27.0 | 20.0 | 62.0 | 47.0 |
| 1 | 6 x 19 | 47.0 | 35.0 | 35.0 | 26.0 | 81.0 | 61.0 |

*These values only apply when the D/d ratio is 20 or greater where:
D = Diameter of curvature around which the body of the sling is bent.
d = Diameter of component rope.

Table H-7
RATED CAPACITIES FOR 2-LEG & 3-LEG BRIDLE SLINGS
6 x 19 AND 6 x 37 CLASSIFICATION IMPROVED PLOW STEEL GRADE ROPE
WITH FIBER CORE (FC)

| Rope | | Rated Capacities, Tons (2,000 lb) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2-Leg Bridle Slings | | | | | | 3-Leg Bridle Slings | | | | | |
| Dia (Inches) | Constr | Vert 90 degree Horz 60 degree | | 45 degree Angle | | Vert 60 degree Horz 30 degree | | Vert 90 degree Horz 60 degree | | 45 degree Angle | | Vert 60 degree Horz 30 degree | |
| | | HT | MS | HT | MS | HT | MS | HT | MS | HT | MS | HT | MS |
| 1/4 | 6 x 19 | 0.85 | 0.88 | 0.70 | 0.72 | 0.49 | 0.51 | 1.3 | 1.3 | 1.0 | 1.1 | 0.74 | 0.7 |
| 5/16 | 6 x 19 | 1.3 | 1.4 | 1.1 | 1.1 | 0.76 | 0.79 | 2.0 | 2.0 | 1.6 | 1.7 | 1.1 | 1.2 |
| 3/8 | 6 x 19 | 1.8 | 1.9 | 1.5 | 1.6 | 1.1 | 1.1 | 2.8 | 2.9 | 2.3 | 2.4 | 1.6 | 1.7 |
| 7/16 | 6 x 19 | 2.5 | 2.6 | 2.0 | 2.2 | 1.4 | 1.5 | 3.7 | 4.0 | 3.0 | 3.2 | 2.1 | 2.3 |
| 1/2 | 6 x 19 | 3.2 | 3.4 | 2.6 | 2.8 | 1.8 | 2.0 | 4.8 | 5.1 | 3.9 | 4.2 | 2.8 | 3.0 |
| 9/16 | 6 x 19 | 4.0 | 4.3 | 3.2 | 3.5 | 2.3 | 2.5 | 6.0 | 6.5 | 4.9 | 5.3 | 3.4 | 3.7 |
| 5/8 | 6 x 19 | 4.8 | 5.3 | 4.0 | 4.4 | 2.8 | 3.1 | 7.3 | 8.0 | 5.9 | 6.5 | 4.2 | 4.6 |
| 3/4 | 6 x 19 | 6.8 | 7.6 | 5.5 | 6.2 | 3.9 | 4.4 | 10.0 | 11.0 | 8.3 | 9.3 | 5.8 | 6.6 |
| 7/8 | 6 x 19 | 8.9 | 10.0 | 7.3 | 8.4 | 5.1 | 5.9 | 13.0 | 15.0 | 11.0 | 13.0 | 7.7 | 8.9 |
| 1 | 6 x 19 | 11.0 | 13.0 | 9.4 | 11.0 | 6.7 | 7.7 | 17.0 | 20.0 | 14.0 | 16.0 | 10.0 | 11.0 |
| 1-1/8 | 6 x 19 | 14.0 | 16.0 | 12.0 | 13.0 | 8.4 | 9.5 | 22.0 | 24.0 | 18.0 | 20.0 | 13.0 | 14.0 |
| 1-1/4 | 6 x 37 | 17.0 | 19.0 | 14.0 | 16.0 | 9.8 | 11.0 | 25.0 | 29.0 | 21.0 | 23.0 | 15.0 | 17.0 |
| 1-3/8 | 6 x 37 | 20.0 | 23.0 | 17.0 | 19.0 | 12.0 | 13.0 | 31.0 | 35.0 | 25.0 | 28.0 | 18.0 | 20.0 |
| 1-1/2 | 6 x 37 | 24.0 | 27.0 | 20.0 | 22.0 | 14.0 | 16.0 | 36.0 | 41.0 | 30.0 | 33.0 | 21.0 | 24.0 |
| 1-5/8 | 6 x 37 | 28.0 | 32.0 | 23.0 | 26.0 | 16.0 | 18.0 | 43.0 | 48.0 | 35.0 | 39.0 | 25.0 | 28.0 |
| 1-3/4 | 6 x 37 | 33.0 | 37.0 | 27.0 | 30.0 | 19.0 | 21.0 | 49.0 | 56.0 | 40.0 | 45.0 | 28.0 | 32.0 |
| 2 | 6 x 37 | 43.0 | 48.0 | 35.0 | 39.0 | 25.0 | 28.0 | 64.0 | 72.0 | 52.0 | 59.0 | 37.0 | 41.0 |

HT = Hand Tucked Splice.
MS = Mechanical Splice

Table H-8
RATED CAPACITIES FOR 2-LEG & 3-LEG BRIDLE SLINGS
6 x 19 and 6 x 37 CLASSIFICATION IMPROVED PLOW STEEL GRADE ROPE
WITH INDEPENDENT WIRE ROPE CORE (IWRC)

| Rope | | Rated Capacities, Tons (2,000 lb) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2-Leg Bridle Sling | | | | | | 3-Leg Bridle Sling | | | | | |
| Dia (Inches) | Constr | Vert 90 degree Horz 60 degree | | 45 degree Angle | | Vert 60 degree Horz 30 degree | | Vert 90 degree Horz 60 degree | | 45 degree Angle | | Vert 60 degree Horz 30 degree | |
| | | HT | MS | HT | MS | HT | MS | HT | MS | HT | MS | HT | MS |
| 1/4 | 6 x 19 | 0.92 | 0.97 | 0.75 | 0.79 | 0.53 | 0.56 | 1.4 | 1.4 | 1.1 | 1.2 | 0.79 | 0.84 |
| 5/16 | 6 x 19 | 1.4 | 1.5 | 1.1 | 1.2 | 1.81 | 0.87 | 2.1 | 2.3 | 1.7 | 1.8 | 1.2 | 1.3 |
| 3/8 | 6 x 19 | 2.0 | 2.1 | 1.6 | 1.8 | 1.1 | 1.2 | 3.0 | 3.2 | 2.4 | 2.6 | 1.7 | 1.9 |
| 7/16 | 6 x 19 | 2.7 | 2.9 | 2.2 | 2.4 | 1.5 | 1.7 | 4.0 | 4.4 | 3.3 | 3.6 | 2.3 | 2.5 |
| 1/2 | 6 x 19 | 3.4 | 3.8 | 2.8 | 3.1 | 2.0 | 2.2 | 5.1 | 5.7 | 4.2 | 4.6 | 3.0 | 3.3 |
| 9/16 | 6 x 19 | 4.3 | 4.8 | 3.5 | 3.9 | 2.5 | 2.7 | 6.4 | 7.1 | 5.2 | 5.8 | 3.7 | 4.1 |
| 5/8 | 6 x 19 | 5.2 | 5.9 | 4.2 | 4.8 | 3.0 | 3.4 | 7.8 | 8.8 | 6.4 | 7.2 | 4.5 | 5.1 |
| 3/4 | 6 x 19 | 7.3 | 8.4 | 5.9 | 6.9 | 4.2 | 4.9 | 11.0 | 13.0 | 8.9 | 10.0 | 6.3 | 7.3 |
| 7/8 | 6 x 19 | 9.6 | 11.0 | 7.8 | 9.3 | 5.5 | 6.6 | 14.0 | 17.0 | 12.0 | 14.0 | 8.3 | 9.9 |
| 1 | 6 x 19 | 12.0 | 15.0 | 10.0 | 12.0 | 7.2 | 8.5 | 19.0 | 22.0 | 15.0 | 18.0 | 11.0 | 13.0 |
| 1-1/8 | 6 x 19 | 16.0 | 18.0 | 13.0 | 15.0 | 9.0 | 10.0 | 23.0 | 27.0 | 19.0 | 22.0 | 13.0 | 16.0 |
| 1-1/4 | 6 x 37 | 18.0 | 21.0 | 15.0 | 17.0 | 10.0 | 12.0 | 27.0 | 32.0 | 22.0 | 26.0 | 16.0 | 18.0 |
| 1-3/8 | 6 x 37 | 22.0 | 25.0 | 18.0 | 21.0 | 13.0 | 15.0 | 33.0 | 38.0 | 27.0 | 31.0 | 19.0 | 22.0 |
| 1-1/2 | 6 x 37 | 26.0 | 30.0 | 21.0 | 25.0 | 15.0 | 17.0 | 39.0 | 45.0 | 32.0 | 37.0 | 23.0 | 26.0 |
| 1-5/8 | 6 x 37 | 31.0 | 35.0 | 25.0 | 29.0 | 18.0 | 20.0 | 46.0 | 53.0 | 38.0 | 43.0 | 27.0 | 31.0 |
| 1-3/4 | 6 x 37 | 35.0 | 41.0 | 29.0 | 33.0 | 20.0 | 24.0 | 53.0 | 61.0 | 43.0 | 50.0 | 31.0 | 35.0 |
| 2 | 6 x 37 | 46.0 | 53.0 | 37.0 | 43.0 | 26.0 | 30.0 | 68.0 | 79.0 | 56.0 | 65.0 | 40.0 | 46.0 |

HT = Hand Tucked Splice
MS = Mechanical Splice

## Table H-9

**RATED CAPACITIES FOR 2-LEG & 3-LEG BRIDLE SLINGS**
**CABLE LAID ROPE – MECHANICAL SPLICE ONLY**
**7×7×7 AND 7×7×19 CONSTRUCTIONS GALVANIZED AIRCRAFT GRADE ROPE**
**7×6×19 IWRC CONSTRUCTION IMPROVED PLOW STEEL GRADE ROPE**

| Rope | | Rated Capacities, Tons (2,000 lb) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2-Leg Bridle Sling | | | 3-Leg Bridle Sling | | |
| Dia (inches) | Constr | Vert 30 deg Horz 60 deg | 45 degree Angle | Vert 60 deg Horz 30 deg | Vert 30 deg Horz 60 deg | 45 degree Angle | Vert 60 deg Horz 30 deg |
| 1/4 | 7×7×7 | 0.87 | 0.71 | 0.50 | 1.3 | 1.1 | 0.75 |
| 3/8 | 7×7×7 | 1.9 | 1.5 | 1.1 | 2.8 | 2.3 | 1.6 |
| 1/2 | 7×7×7 | 3.2 | 2.6 | 1.8 | 4.8 | 3.9 | 2.8 |
| 5/8 | 7×7×7 | 4.8 | 3.9 | 2.8 | 7.2 | 5.9 | 4.2 |
| 3/4 | 7×7×7 | 6.6 | 5.4 | 3.8 | 9.9 | 8.1 | 5.7 |
| 5/8 | 7×7×19 | 5.0 | 4.1 | 2.9 | 7.5 | 6.1 | 4.3 |
| 3/4 | 7×7×19 | 7.0 | 5.7 | 4.1 | 10.0 | 8.6 | 6.1 |
| 7/8 | 7×7×19 | 9.3 | 7.6 | 5.4 | 14.0 | 11.0 | 8.1 |
| 1 | 7×7×19 | 12.0 | 9.7 | 6.9 | 18.0 | 14.0 | 10.0 |
| 1-1/8 | 7×7×19 | 14.0 | 12.0 | 8.2 | 21.0 | 17.0 | 12.0 |
| 1-1/4 | 7×7×19 | 17.0 | 14.0 | 9.9 | 26.0 | 21.0 | 15.0 |
| 3/4 | 7×6×19 IWRC | 6.6 | 5.4 | 3.8 | 9.9 | 8.0 | 5.7 |
| 7/8 | 7×6×19 IWRC | 8.7 | 7.1 | 5.0 | 13.0 | 11.0 | 7.5 |
| 1 | 7×6×19 IWRC | 11.0 | 9.0 | 6.4 | 17.0 | 13.0 | 9.6 |
| 1-1/8 | 7×6×19 IWRC | 13.0 | 11.0 | 7.7 | 20.0 | 16.0 | 11.0 |
| 1-1/4 | 7×6×19 IWRC | 16.0 | 13.0 | 9.2 | 24.0 | 20.0 | 14.0 |
| 1-5/16 | 7×6×19 IWRC | 17.0 | 14.0 | 10.0 | 26.0 | 21.0 | 15.0 |
| 1-3/8 | 7×6×19 IWRC | 19.0 | 15.0 | 11.0 | 28.0 | 23.0 | 16.0 |
| 1-1/2 | 7×6×19 IWRC | 22.0 | 18.0 | 13.0 | 33.0 | 27.0 | 19.0 |

## Table H-10

**RATED CAPACITIES FOR 2-LEG AND 3-LEG BRIDLE SLINGS**
**8-PART AND 6-PART BRAIDED ROPE**
**6×7 AND 6×19 CONSTRUCTION IMPROVED PLOW STEEL GRADE ROPE**
**7×7 CONSTRUCTION GALVANIZED AIRCRAFT GRADE ROPE**

| Component Rope | | Rated Capacities, Tons (2,000 lb) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2-Leg Bridle Slings | | | | | | 3-Leg Bridle Slings | | | | | |
| | | Vert 30 degree Horz 60 degree | | 45 degree Angle | | Vert 60 degree Horz 30 degree | | Vert 30 degree Horz 60 degree | | 45 degree Angle | | Vert 60 degree Horz 30 degree | |
| Dia (inches) | Constr | 8-Part | 6-Part | 8-Part | 6-Part | 8-Part | 6-Part | 8-Part | 6-Part | 8-Part | 6-Part | 8-Part | 6-Part |
| 3/32 | 6×7 | 0.74 | 0.55 | 0.60 | 0.45 | 0.42 | 0.32 | 1.1 | 0.83 | 0.90 | 0.68 | 0.64 | 0.48 |
| 1/8 | 6×7 | 1.3 | 0.98 | 1.1 | 0.80 | 0.76 | 0.57 | 2.0 | 1.5 | 1.6 | 1.2 | 1.1 | 0.85 |
| 3/16 | 6×7 | 2.9 | 2.2 | 2.4 | 1.8 | 1.7 | 1.3 | 4.4 | 3.3 | 3.6 | 2.7 | 2.5 | 1.9 |
| 3/32 | 7×7 | 0.89 | 0.67 | 0.72 | 0.55 | 0.51 | 0.39 | 1.3 | 1.0 | 1.1 | 0.82 | 0.77 | 0.58 |
| 1/8 | 7×7 | 1.6 | 1.2 | 1.3 | 1.0 | 0.95 | 0.71 | 2.5 | 1.8 | 2.0 | 1.5 | 1.4 | 1.1 |
| 3/16 | 7×7 | 3.6 | 2.7 | 2.9 | 2.2 | 2.1 | 1.5 | 5.4 | 4.0 | 4.4 | 3.3 | 3.1 | 2.3 |
| 3/16 | 6×19 | 3.0 | 2.2 | 2.4 | 1.8 | 1.7 | 1.3 | 4.5 | 3.4 | 3.7 | 2.8 | 2.6 | 1.9 |
| 1/4 | 6×19 | 5.3 | 4.0 | 4.3 | 3.2 | 3.1 | 2.3 | 8.0 | 6.0 | 6.5 | 4.9 | 4.6 | 3.4 |
| 5/16 | 6×19 | 8.3 | 6.2 | 6.7 | 5.0 | 4.8 | 3.6 | 12.0 | 9.3 | 10.0 | 7.6 | 7.1 | 5.4 |
| 3/8 | 6×19 | 12.0 | 8.9 | 9.7 | 7.2 | 6.8 | 5.1 | 18.0 | 13.0 | 14.0 | 11.0 | 10.0 | 7.7 |
| 7/16 | 6×19 | 16.0 | 12.0 | 13.0 | 9.8 | 9.3 | 6.9 | 24.0 | 18.0 | 20.0 | 15.0 | 14.0 | 10.0 |
| 1/2 | 6×19 | 21.0 | 15.0 | 17.0 | 13.0 | 12.0 | 9.0 | 31.0 | 23.0 | 25.0 | 19.0 | 18.0 | 13.0 |
| 9/16 | 6×19 | 26.0 | 20.0 | 21.0 | 16.0 | 15.0 | 11.0 | 39.0 | 29.0 | 32.0 | 24.0 | 23.0 | 17.0 |
| 5/8 | 6×19 | 32.0 | 24.0 | 26.0 | 20.0 | 19.0 | 14.0 | 48.0 | 36.0 | 40.0 | 30.0 | 28.0 | 21.0 |
| 3/4 | 6×19 | 46.0 | 35.0 | 38.0 | 28.0 | 27.0 | 20.0 | 69.0 | 52.0 | 56.0 | 42.0 | 40.0 | 30.0 |
| 7/8 | 6×19 | 62.0 | 47.0 | 51.0 | 38.0 | 36.0 | 27.0 | 94.0 | 70.0 | 76.0 | 57.0 | 54.0 | 40.0 |
| 1 | 6×19 | 81.0 | 61.0 | 66.0 | 50.0 | 47.0 | 35.0 | 22.0 | 91.0 | 99.0 | 74.0 | 70.0 | 53.0 |

Table H-11
RATED CAPACITIES FOR STRAND LAID GROMMET – HAND TUCKED
IMPROVED PLOW STEEL GRADE ROPE

| ROPE BODY | | RATED CAPACITIES, TONS (2,000 lb) | | |
|---|---|---|---|---|
| Dia (inches) | Constr | Vertical | Choker | Vertical Basket* |
| 1/4 | 7 x 19 | 0.85 | 0.64 | 1.7 |
| 5/16 | 7 x 19 | 1.3 | 1.0 | 2.6 |
| 3/8 | 7 x 19 | 1.9 | 1.4 | 3.8 |
| 7/16 | 7 x 19 | 2.6 | 1.9 | 5.2 |
| 1/2 | 7 x 19 | 3.3 | 2.5 | 6.7 |
| 9/16 | 7 x 19 | 4.2 | 3.1 | 8.4 |
| 5/8 | 7 x 19 | 5.2 | 3.9 | 10.00 |
| 3/4 | 7 x 19 | 7.4 | 5.6 | 15.0 |
| 7/8 | 7 x 19 | 10.0 | 7.5 | 20.0 |
| 1 | 7 x 19 | 13.0 | 9.7 | 26.0 |
| 1-1/8 | 7 x 19 | 16.0 | 12.0 | 32.0 |
| 1-1/4 | 7 x 37 | 18.0 | 14.0 | 37.0 |
| 1-3/8 | 7 x 37 | 22.0 | 16.0 | 44.0 |
| 1-1/2 | 7 x 37 | 26.0 | 19.0 | 52.0 |

* These values only apply when the D/d ratio is 5 or greater where:
D = Diameter of curvature around which rope is bent.
d = Diameter of rope body.

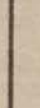
Table H-12
RATED CAPACITIES FOR CABLE LAID GROMMET – HAND TUCKED
7 x 6 x 7 AND 7 x 6 x 19 CONSTRUCTIONS IMPROVED PLOW STEEL GRADE ROPE
7 x 7 x 7 CONSTRUCTION GALVANIZED AIRCRAFT GRADE ROPE

| CABLE BODY | | RATED CAPACITIES, TONS (2,000 lb) | | |
|---|---|---|---|---|
| Dia (inches) | Constr | Vertical | Choker | Vertical Basket* |
| 3/8 | 7 x 6 x 7 | 1.3 | 0.95 | 2.5 |
| 9/16 | 7 x 6 x 7 | 2.8 | 2.1 | 5.6 |
| 5/8 | 7 x 6 x 7 | 3.8 | 2.8 | 7.6 |
| 3/8 | 7 x 7 x 7 | 1.6 | 1.2 | 3.2 |
| 9/16 | 7 x 7 x 7 | 3.5 | 2.6 | 6.9 |
| 5/8 | 7 x 7 x 7 | 4.5 | 3.4 | 9.0 |
| 5/8 | 7 x 6 x 19 | 3.9 | 3.0 | 7.9 |
| 3/4 | 7 x 6 x 19 | 5.1 | 3.8 | 10.0 |
| 15/16 | 7 x 6 x 19 | 7.9 | 5.9 | 16.0 |
| 1-1/8 | 7 x 6 x 19 | 11.0 | 8.4 | 22.0 |
| 1-5/16 | 7 x 6 x 19 | 15.0 | 11.0 | 30.0 |
| 1-1/2 | 7 x 6 x 19 | 19.0 | 14.0 | 39.0 |
| 1-11/16 | 7 x 6 x 19 | 24.0 | 18.0 | 49.0 |
| 1-7/8 | 7 x 6 x 19 | 30.0 | 22.0 | 60.0 |
| 2-1/4 | 7 x 6 x 19 | 42.0 | 31.0 | 84.0 |
| 2-5/8 | 7 x 6 x 19 | 56.0 | 42.0 | 112.0 |

* These values only apply when the D/d ratio is 5 or greater where:
D = Diameter of curvature around which cable body is bent.
d = Diameter of cable body.

Table H-13

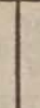
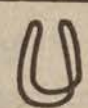
RATED CAPACITIES FOR STRAND LAID ENDLESS SLINGS-MECHANICAL JOINT IMPROVED PLOW STEEL GRADE ROPE

| ROPE BODY | | RATED CAPACITIES, TONS (2,000 lb) | | |
|---|---|---|---|---|
| Dia (Inches) | Constr |  Vertical | Choker | Vertical Basket* |
| 1/4 | 6 x 19 IWRC | 0.92 | 0.69 | 1.8 |
| 3/8 | 6 x 19 IWRC | 2.0 | 1.5 | 4.1 |
| 1/2 | 6 x 19 IWRC | 3.6 | 2.7 | 7.2 |
| 5/8 | 6 x 19 IWRC | 5.6 | 4.2 | 11.0 |
| 3/4 | 6 x 19 IWRC | 8.0 | 6.0 | 16.0 |
| 7/8 | 6 x 19 IWRC | 11.0 | 8.1 | 21.0 |
| 1 | 6 x 19 IWRC | 14.0 | 10.0 | 28.0 |
| 1-1/8 | 6 x 19 IWRC | 18.0 | 13.0 | 35.0 |
| 1-1/4 | 6 x 37 IWRC | 21.0 | 15.0 | 41.0 |
| 1-3/8 | 6 x 37 IWRC | 25.0 | 19.0 | 50.0 |
| 1-1/2 | 6 x 37 IWRC | 29.0 | 22.0 | 59.0 |

*These values only apply when the D/d ratio is 5 or greater where:
D = Diameter of curvature around which rope is bent.
d = Diameter of rope body.

Table H-14

RATED CAPACITIES FOR CABLE LAID ENDLESS SLINGS-MECHANICAL JOINT 7 x 7 x 7 AND 7 x 7 x 19 CONSTRUCTIONS GALVANIZED AIRCRAFT GRADE ROPE 7 x 6 x 19 IWRC CONSTRUCTION IMPROVED PLOW STEEL GRADE ROPE

| CABLE BODY | | RATED CAPACITIES, TONS (2,000 lb) | | |
|---|---|---|---|---|
| Dia (Inches) | Constr |  Vertical | Choker |  Vertical Basket* |
| 1/4 | 7 x 7 x 7 | 0.83 | 0.62 | 1.6 |
| 3/8 | 7 x 7 x 7 | 1.8 | 1.3 | 3.5 |
| 1/2 | 7 x 7 x 7 | 3.0 | 2.3 | 6.1 |
| 5/8 | 7 x 7 x 7 | 4.5 | 3.4 | 9.1 |
| 3/4 | 7 x 7 x 7 | 6.3 | 4.7 | 12.0 |
| 5/8 | 7 x 7 x 19 | 4.7 | 3.5 | 9.5 |
| 3/4 | 7 x 7 x 19 | 6.7 | 5.0 | 13.0 |
| 7/8 | 7 x 7 x 19 | 8.9 | 6.6 | 18.0 |
| 1 | 7 x 7 x 19 | 11.0 | 8.5 | 22.0 |
| 1-1/8 | 7 x 7 x 19 | 14.0 | 10.0 | 28.0 |
| 1-1/4 | 7 x 7 x 19 | 17.0 | 12.0 | 33.0 |
| 3/4 | 7 x 6 x 19 IWRC | 6.2 | 4.7 | 12.0 |
| 7/8 | 7 x 6 x 19 IWRC | 8.3 | 6.2 | 16.0 |
| 1 | 7 x 6 x 19 IWRC | 10.0 | 7.9 | 21.0 |
| 1-1/8 | 7 x 6 x 19 IWRC | 13.0 | 9.7 | 26.0 |
| 1-1/4 | 7 x 6 x 19 IWRC | 16.0 | 12.0 | 31.0 |
| 1-3/8 | 7 x 6 x 19 IWRC | 18.0 | 14.0 | 37.0 |
| 1-1/2 | 7 x 6 x 19 IWRC | 22.0 | 16.0 | 43.0 |

*These values only apply when the D/d value is 5 or greater where:
D = Diameter of curvature around which cable body is bent.
d = Diameter of cable body.

Table H-15
MANILA ROPE SLINGS

| ROPE DIAMETER Nominal In Inches | Nominal Weight Per 100 ft In Pounds | Minimum Breaking Strength In Pounds | RATED CAPACITY IN POUNDS (Safety Factor = 5) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | EYE AND EYE SLING | | | | | | ENDLESS SLING | | | | | |
| | | | VERTICAL HITCH | CHOKER HITCH | BASKET HITCH | | | | VERTICAL HITCH | CHOKER HITCH | BASKET HITCH | | | |
| | | | | | Angle of Rope to Horizontal | | | | | | Angle of Rope to Horizontal | | | |
| | | | | | 90 deg | 60 deg | 45 deg | 30 deg | | | 90 deg | 60 deg | 45 deg | 30 deg |
| | | | | | Angle of Rope to Vertical | | | | | | Angle of Rope to Vertical | | | |
| | | | | | 0 deg | 30 deg | 45 deg | 60 deg | | | 0 deg | 30 deg | 45 deg | 60 deg |
| 1/2 | 7.5 | 2,650 | 550 | 250 | 1,100 | 900 | 750 | 550 | 950 | 500 | 1,900 | 1,700 | 1,400 | 950 |
| 9/16 | 10.4 | 3,450 | 700 | 350 | 1,400 | 1,200 | 1,000 | 700 | 1,200 | 600 | 2,500 | 2,200 | 1,800 | 1,200 |
| 5/8 | 13.3 | 4,400 | 900 | 450 | 1,800 | 1,500 | 1,200 | 900 | 1,600 | 800 | 3,200 | 2,700 | 2,200 | 1,600 |
| 3/4 | 16.7 | 5,400 | 1,100 | 550 | 2,200 | 1,900 | 1,500 | 1,100 | 2,000 | 950 | 3,900 | 3,400 | 2,800 | 2,000 |
| 13/16 | 19.5 | 6,500 | 1,300 | 650 | 2,600 | 2,300 | 1,800 | 1,300 | 2,300 | 1,200 | 4,700 | 4,100 | 3,300 | 2,300 |
| 7/8 | 22.5 | 7,700 | 1,500 | 750 | 3,100 | 2,700 | 2,200 | 1,500 | 2,800 | 1,400 | 5,600 | 4,800 | 3,900 | 2,800 |
| 1 | 27.0 | 9,000 | 1,800 | 900 | 3,600 | 3,100 | 2,600 | 1,800 | 3,200 | 1,600 | 6,500 | 5,600 | 4,600 | 3,200 |
| 1 1/16 | 31.3 | 10,500 | 2,100 | 1,100 | 4,200 | 3,600 | 3,000 | 2,100 | 3,800 | 1,900 | 7,600 | 6,600 | 5,400 | 3,800 |
| 1 1/8 | 36.0 | 12,000 | 2,400 | 1,200 | 4,800 | 4,200 | 3,400 | 2,400 | 4,300 | 2,200 | 8,600 | 7,500 | 6,100 | 4,300 |
| 1 1/4 | 41.7 | 13,500 | 2,700 | 1,400 | 5,400 | 4,700 | 3,800 | 2,700 | 4,900 | 2,400 | 9,700 | 8,400 | 6,900 | 4,900 |
| 1 5/16 | 47.9 | 15,000 | 3,000 | 1,500 | 6,000 | 5,200 | 4,300 | 3,000 | 5,400 | 2,700 | 11,000 | 9,400 | 7,700 | 5,400 |
| 1 1/2 | 59.9 | 18,500 | 3,700 | 1,850 | 7,400 | 6,400 | 5,200 | 3,700 | 6,700 | 3,300 | 13,500 | 11,500 | 9,400 | 6,700 |
| 1 5/8 | 74.6 | 22,500 | 4,500 | 2,300 | 9,000 | 7,800 | 6,400 | 4,500 | 8,100 | 4,100 | 16,000 | 14,000 | 11,500 | 8,000 |
| 1 3/4 | 89.3 | 26,500 | 5,300 | 2,700 | 10,500 | 9,200 | 7,500 | 5,300 | 9,500 | 4,800 | 19,000 | 16,500 | 13,500 | 9,500 |
| 2 | 107.5 | 31,000 | 6,200 | 3,100 | 12,500 | 10,500 | 8,800 | 6,200 | 11,000 | 5,600 | 22,500 | 19,500 | 16,000 | 11,000 |
| 2 1/3 | 125.0 | 36,000 | 7,200 | 3,600 | 14,500 | 12,500 | 10,000 | 7,200 | 13,000 | 6,500 | 26,000 | 22,500 | 18,500 | 13,000 |
| 2 1/4 | 146.0 | 41,000 | 8,200 | 4,100 | 16,500 | 14,000 | 11,500 | 8,200 | 15,000 | 7,400 | 29,500 | 25,500 | 21,000 | 15,000 |
| 2 1/2 | 166.7 | 46,500 | 9,300 | 4,700 | 18,500 | 16,000 | 13,000 | 9,300 | 16,500 | 8,400 | 33,500 | 29,000 | 23,500 | 16,500 |
| 2 5/8 | 190.8 | 52,000 | 10,500 | 5,200 | 21,000 | 18,000 | 14,500 | 10,500 | 18,500 | 9,500 | 37,500 | 32,500 | 26,500 | 18,500 |

Table H-16
NYLON ROPE SLINGS

| ROPE DIAMETER Nominal In Inches | Nominal Weight Per 100 ft In Pounds | Minimum Breaking Strength In Pounds | RATED CAPACITY IN POUNDS (Safety Factor = 9) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | EYE AND EYE SLING | | | | | | ENDLESS SLING | | | | | |
| | | | VERTICAL HITCH | CHOKER HITCH | BASKET HITCH | | | | VERTICAL HITCH | CHOKER HITCH | BASKET HITCH | | | |
| | | | | | Angle of Rope to Horizontal | | | | | | Angle of Rope to Horizontal | | | |
| | | | | | 90 deg | 60 deg | 45 deg | 30 deg | | | 90 deg | 60 deg | 45 deg | 30 deg |
| | | | | | Angle of Rope to Vertical | | | | | | Angle of Rope to Vertical | | | |
| | | | | | 0 deg | 30 deg | 45 deg | 60 deg | | | 0 deg | 30 deg | 45 deg | 60 deg |
| 1/2 | 6.5 | 6,080 | 700 | 350 | 1,400 | 1,200 | 950 | 700 | 1,200 | 600 | 2,400 | 2,100 | 1,700 | 1,200 |
| 9/16 | 8.3 | 7,600 | 850 | 400 | 1,700 | 1,500 | 1,200 | 850 | 1,500 | 750 | 3,000 | 2,600 | 2,200 | 1,500 |
| 5/8 | 10.5 | 9,880 | 1,100 | 550 | 2,200 | 1,900 | 1,600 | 1,100 | 2,000 | 1,000 | 4,000 | 3,400 | 2,800 | 2,000 |
| 3/4 | 14.5 | 13,490 | 1,500 | 750 | 3,000 | 2,600 | 2,100 | 1,500 | 2,700 | 1,400 | 5,400 | 4,700 | 3,800 | 2,700 |
| 13/16 | 17.0 | 16,150 | 1,800 | 900 | 3,600 | 3,100 | 2,600 | 1,800 | 3,200 | 1,600 | 6,400 | 5,600 | 4,600 | 3,200 |
| 7/8 | 20.0 | 19,000 | 2,100 | 1,100 | 4,200 | 3,700 | 3,000 | 2,100 | 3,800 | 1,900 | 7,600 | 6,600 | 5,400 | 3,800 |
| 1 | 26.0 | 23,750 | 2,600 | 1,300 | 5,300 | 4,600 | 3,700 | 2,600 | 4,800 | 2,400 | 9,500 | 8,200 | 6,700 | 4,800 |
| 1 1/16 | 29.0 | 27,360 | 3,000 | 1,500 | 6,100 | 5,300 | 4,300 | 3,000 | 5,500 | 2,700 | 11,000 | 9,500 | 7,700 | 5,500 |
| 1 1/8 | 34.0 | 31,350 | 3,500 | 1,700 | 7,000 | 6,000 | 5,000 | 3,500 | 6,300 | 3,100 | 12,500 | 11,000 | 8,900 | 6,300 |
| 1 1/4 | 40.0 | 35,625 | 4,000 | 2,000 | 7,900 | 6,900 | 5,600 | 4,000 | 7,100 | 3,600 | 14,500 | 12,500 | 10,000 | 7,100 |
| 1 5/16 | 45.0 | 40,850 | 4,500 | 2,300 | 9,100 | 7,900 | 6,400 | 4,500 | 8,200 | 4,100 | 16,500 | 14,000 | 12,000 | 8,200 |
| 1 1/2 | 55.0 | 50,350 | 5,600 | 2,800 | 11,000 | 9,700 | 7,900 | 5,600 | 10,000 | 5,000 | 20,000 | 17,500 | 14,000 | 10,000 |
| 1 5/8 | 68.0 | 61,750 | 6,900 | 3,400 | 13,500 | 12,000 | 9,700 | 6,900 | 12,500 | 6,200 | 24,500 | 21,500 | 17,500 | 12,500 |
| 1 3/4 | 83.0 | 74,100 | 8,200 | 4,100 | 16,500 | 14,500 | 11,500 | 8,200 | 15,000 | 7,400 | 29,500 | 27,500 | 21,000 | 15,000 |
| 2 | 95.0 | 87,400 | 9,700 | 4,900 | 19,500 | 17,000 | 13,500 | 9,700 | 17,500 | 8,700 | 35,000 | 30,500 | 24,500 | 17,500 |
| 2 1/8 | 109.0 | 100,700 | 11,000 | 5,600 | 22,500 | 19,500 | 16,000 | 11,000 | 20,000 | 10,000 | 40,500 | 35,000 | 28,500 | 20,000 |
| 2 1/4 | 129.0 | 118,750 | 13,000 | 6,600 | 26,500 | 23,000 | 18,500 | 13,000 | 24,000 | 12,000 | 47,500 | 41,000 | 33,500 | 24,000 |
| 2 1/2 | 148.0 | 138,000 | 15,000 | 7,400 | 29,500 | 25,500 | 21,000 | 15,000 | 26,500 | 13,500 | 53,000 | 46,000 | 37,500 | 26,500 |
| 2 5/8 | 168.0 | 153,900 | 17,100 | 8,600 | 34,000 | 29,500 | 24,000 | 17,000 | 31,000 | 15,500 | 61,500 | 53,500 | 43,500 | 31,000 |

Table H-17
POLYESTER ROPE SLINGS

| ROPE DIAMETER Nominal In Inches | Nominal Weight Per 100 ft In Pounds | Minimum Breaking Strength In Pounds | RATED CAPACITY IN POUNDS (Safety Factor = 9) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | EYE AND EYE SLING | | | | | | ENDLESS SLING | | | | | |
| | | | VERTICAL HITCH | CHOKER HITCH | BASKET HITCH | | | | VERTICAL HITCH | CHOKER HITCH | BASKET HITCH | | | |
| | | | | | Angle of Rope to Horizontal | | | | | | Angle of Rope to Horizontal | | | |
| | | | | | 90 deg | 60 deg | 45 deg | 30 deg | | | 90 deg | 60 deg | 45 deg | 30 deg |
| | | | | | Angle of Rope to Vertical | | | | | | Angle of Rope to Vertical | | | |
| | | | | | 0 deg | 30 deg | 45 deg | 60 deg | | | 0 deg | 30 deg | 45 deg | 60 deg |
| 1/2 | 8.0 | 6,080 | 700 | 350 | 1,400 | 1,200 | 950 | 700 | 1,200 | 600 | 2,400 | 2,100 | 1,700 | 1,200 |
| 9/16 | 10.2 | 7,600 | 850 | 400 | 1,700 | 1,500 | 1,200 | 850 | 1,500 | 750 | 3,000 | 2,600 | 2,200 | 1,500 |
| 5/8 | 13.0 | 9,500 | 1,100 | 550 | 2,100 | 1,800 | 1,500 | 1,100 | 1,900 | 950 | 3,800 | 3,300 | 2,700 | 1,900 |
| 3/4 | 17.5 | 11,875 | 1,300 | 650 | 2,600 | 2,300 | 1,900 | 1,300 | 2,400 | 1,200 | 4,800 | 4,100 | 3,400 | 2,400 |
| 13/16 | 21.0 | 14,725 | 1,600 | 800 | 3,300 | 2,800 | 2,300 | 1,600 | 2,900 | 1,500 | 5,900 | 5,100 | 4,200 | 2,900 |
| 7/8 | 25.0 | 17,100 | 1,900 | 950 | 3,800 | 3,300 | 2,700 | 1,900 | 3,400 | 1,700 | 6,800 | 5,900 | 4,800 | 3,400 |
| 1 | 30.5 | 20,900 | 2,300 | 1,200 | 4,600 | 4,000 | 3,300 | 2,300 | 4,200 | 2,100 | 8,400 | 7,200 | 5,900 | 4,200 |
| 1 1/16 | 34.5 | 24,225 | 2,700 | 1,300 | 5,400 | 4,700 | 3,800 | 2,700 | 4,800 | 2,400 | 9,700 | 8,400 | 6,900 | 4,800 |
| 1 1/8 | 40.0 | 28,025 | 3,100 | 1,600 | 6,200 | 5,400 | 4,400 | 3,100 | 5,600 | 2,800 | 11,000 | 9,700 | 7,900 | 5,600 |
| 1 1/4 | 46.3 | 31,540 | 3,500 | 1,800 | 7,000 | 6,100 | 5,000 | 3,500 | 6,200 | 3,200 | 12,500 | 11,000 | 8,900 | 6,300 |
| 1 5/16 | 52.5 | 35,625 | 4,000 | 2,000 | 7,900 | 6,900 | 5,600 | 4,000 | 7,100 | 3,600 | 14,500 | 12,500 | 10,000 | 7,100 |
| 1 1/2 | 66.8 | 44,460 | 4,900 | 2,500 | 9,900 | 8,600 | 7,000 | 4,900 | 8,900 | 4,400 | 18,000 | 15,500 | 12,500 | 8,900 |
| 1 5/8 | 82.0 | 54,150 | 6,000 | 3,000 | 12,000 | 10,400 | 8,500 | 6,000 | 11,000 | 5,400 | 21,500 | 19,000 | 15,500 | 11,000 |
| 1 3/4 | 98.0 | 64,410 | 7,200 | 3,600 | 14,500 | 12,500 | 10,000 | 7,200 | 13,000 | 6,400 | 26,000 | 22,500 | 18,000 | 13,000 |
| 2 | 118.0 | 76,000 | 8,400 | 4,200 | 17,000 | 14,500 | 12,000 | 8,400 | 15,000 | 7,600 | 30,500 | 26,500 | 21,500 | 15,000 |
| 2 1/8 | 135.0 | 87,400 | 9,700 | 4,900 | 19,500 | 17,000 | 13,500 | 9,700 | 17,500 | 8,700 | 35,000 | 30,500 | 24,500 | 17,500 |
| 2 1/4 | 157.0 | 101,650 | 11,500 | 5,700 | 22,500 | 19,500 | 16,000 | 11,500 | 20,500 | 10,000 | 40,500 | 35,000 | 29,000 | 20,500 |
| 2 1/2 | 181.0 | 115,900 | 13,000 | 6,400 | 26,000 | 22,500 | 18,000 | 13,000 | 23,000 | 11,500 | 46,500 | 40,000 | 33,000 | 23,000 |
| 2 5/8 | 205.0 | 130,150 | 14,500 | 7,200 | 29,000 | 25,000 | 20,500 | 14,500 | 26,000 | 13,000 | 52,000 | 45,000 | 37,000 | 26,000 |

Table H-18
POLYPROPYLENE ROPE SLINGS

| ROPE DIAMETER Nominal In Inches | Nominal Weight Per 100 ft In Pounds | Minimum Breaking Strength In Pounds | RATED CAPACITY IN POUNDS (Safety Factor = 6) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | EYE AND EYE SLING | | | | | | ENDLESS SLING | | | | | |
| | | | VERTICAL HITCH | CHOKER HITCH | BASKET HITCH | | | | VERTICAL HITCH | CHOKER HITCH | BASKET HITCH | | | |
| | | | | | Angle of Rope to Horizontal | | | | | | Angle of Rope to Horizontal | | | |
| | | | | | 90 deg | 60 deg | 45 deg | 30 deg | | | 90 deg | 60 deg | 45 deg | 30 deg |
| | | | | | Angle of Rope to Vertical | | | | | | Angle of Rope to Vertical | | | |
| | | | | | 0 deg | 30 deg | 45 deg | 60 deg | | | 0 deg | 30 deg | 45 deg | 60 deg |
| 1/2 | 4.7 | 3,990 | 650 | 350 | 1,300 | 1,200 | 950 | 650 | 1,200 | 600 | 2,400 | 2,100 | 1,700 | 1,200 |
| 9/16 | 6.1 | 4,845 | 800 | 400 | 1,600 | 1,400 | 1,100 | 800 | 1,500 | 750 | 2,900 | 2,500 | 2,100 | 1,500 |
| 5/8 | 7.5 | 5,890 | 1,000 | 500 | 2,000 | 1,700 | 1,400 | 1,000 | 1,800 | 900 | 3,500 | 3,100 | 2,500 | 1,800 |
| 3/4 | 10.7 | 8,075 | 1,300 | 700 | 2,700 | 2,300 | 1,900 | 1,300 | 2,400 | 1,200 | 4,900 | 4,200 | 3,400 | 2,400 |
| 13/16 | 12.7 | 9,405 | 1,600 | 800 | 3,100 | 2,700 | 2,200 | 1,600 | 2,800 | 1,400 | 5,600 | 4,900 | 4,000 | 2,800 |
| 7/8 | 15.0 | 10,925 | 1,800 | 900 | 3,600 | 3,200 | 2,600 | 1,800 | 3,300 | 1,600 | 6,600 | 5,700 | 4,600 | 3,300 |
| 1 | 18.0 | 13,300 | 2,200 | 1,100 | 4,400 | 3,800 | 3,100 | 2,200 | 4,000 | 2,000 | 8,000 | 6,900 | 5,600 | 4,000 |
| 1 1/16 | 20.4 | 15,200 | 2,500 | 1,300 | 5,100 | 4,400 | 3,600 | 2,500 | 4,600 | 2,300 | 9,100 | 7,900 | 6,500 | 4,600 |
| 1 1/8 | 23.7 | 17,385 | 2,900 | 1,500 | 5,800 | 5,000 | 4,100 | 2,900 | 5,200 | 2,600 | 10,500 | 9,000 | 7,400 | 5,200 |
| 1 1/4 | 27.0 | 19,950 | 3,300 | 1,700 | 6,700 | 5,800 | 4,700 | 3,300 | 6,000 | 3,000 | 12,000 | 10,500 | 8,500 | 6,000 |
| 1 5/16 | 30.5 | 22,325 | 3,700 | 1,900 | 7,400 | 6,400 | 5,300 | 3,700 | 6,700 | 3,400 | 13,500 | 11,500 | 9,500 | 6,700 |
| 1 1/2 | 38.5 | 28,215 | 4,700 | 2,400 | 9,400 | 8,100 | 6,700 | 4,700 | 8,500 | 4,200 | 17,000 | 14,500 | 12,000 | 8,500 |
| 1 5/8 | 47.5 | 34,200 | 5,700 | 2,900 | 11,500 | 9,900 | 8,100 | 5,700 | 10,500 | 5,100 | 20,500 | 18,000 | 14,500 | 10,500 |
| 1 3/4 | 57.0 | 40,850 | 6,800 | 3,400 | 13,500 | 12,000 | 9,600 | 6,800 | 12,500 | 6,100 | 24,500 | 21,000 | 17,500 | 12,500 |
| 2 | 69.0 | 49,400 | 8,200 | 4,100 | 16,500 | 14,500 | 11,500 | 8,200 | 15,000 | 7,400 | 29,500 | 25,500 | 21,000 | 15,000 |
| 2 1/8 | 80.0 | 57,950 | 9,700 | 4,800 | 19,500 | 16,500 | 13,500 | 9,700 | 17,500 | 8,700 | 35,000 | 30,100 | 24,500 | 17,500 |
| 2 1/4 | 92.0 | 65,550 | 11,000 | 5,500 | 22,000 | 19,000 | 15,500 | 11,000 | 19,500 | 9,900 | 39,500 | 34,000 | 28,000 | 19,500 |
| 2 1/2 | 107.0 | 76,000 | 12,500 | 6,300 | 25,500 | 22,000 | 18,000 | 12,500 | 23,000 | 11,500 | 45,500 | 39,500 | 32,500 | 23,000 |
| 2 5/8 | 120.0 | 85,500 | 14,500 | 7,100 | 28,500 | 24,500 | 20,000 | 14,500 | 25,500 | 13,000 | 51,500 | 44,500 | 36,500 | 25,500 |

[4510-26-M]

TABLE H-19—SAFE WORKING LOADS FOR SHACKLES

[In tons of 2000 pounds]

| Material size (inches) | Pin diameter (inches) | Safe working load |
|---|---|---|
| ½ | ⅝ | 1.4 |
| ⅝ | ¾ | 2.2 |
| ¾ | ⅞ | 3.2 |
| ⅞ | 1 | 4.3 |
| 1 | 1⅛ | 5.6 |
| 1⅛ | 1¼ | 6.7 |
| 1¼ | 1⅜ | 8.2 |
| 1⅜ | 1½ | 10.0 |
| 1½ | 1⅝ | 11.9 |
| 1¾ | 2 | 16.2 |
| 2 | 2¼ | 21.2 |

TABLE H-20—NUMBER AND SPACING OF U-BOLT WIRE ROPE CLIPS

| Improved plow steel, rope diameter inches | Number of clips | | Minimum spacing (inches) |
|---|---|---|---|
| | Drop forged | Other material | |
| ½ | 3 | 4 | 3 |
| ⅝ | 3 | 4 | 3¾ |
| ¾ | 4 | 5 | 4½ |
| ⅞ | 4 | 5 | 5¼ |
| 1 | 5 | 6 | 6 |
| 1⅛ | 6 | 6 | 6¾ |
| 1¼ | 6 | 7 | 7½ |
| 1⅜ | 7 | 7 | 8¼ |
| 1½ | 7 | 8 | 9 |

## Subpart I—Tools—Hand and Power [1]

Sec.

1926.300 General requirements.

*1910.212 General requirements for all machines.*

1926.301 Handtools.

1926.302 Power operated handtools.

*1910.244 Other portable tools and equipment.*

1926.303 Abrasive wheels and tools.

1926.304 Woodworking tools.

1926.305 Jacks—level and ratchet, screw and hydraulic.

*1910.244 Other portable tools and equipment.*

### § 1926.300 General requirements.

(a) *Condition of tools.* All hand and power tools and similar equipment, whether furnished by the employer or the employee, shall be maintained in a safe condition.

(b) *Guarding.* (1) When power operated tools are designed to accommodate guards, they shall be equipped with such guards when in use.

(2) Belts, gears, shafts, pulleys, sprockets, spindles, drums, fly wheels, chains, or other reciprocating, rotating or moving parts of equipment shall be guarded if such parts are exposed to contact by employees or otherwise create a hazard. Guarding shall meet the requirements as set forth in American National Standards Institute, B15.1-1953 (R1958), Safety Code for Mechanical Power-Transmission Apparatus.

(c) *Personal protective equipment.* Employees using hand and power tools and exposed to the hazard of falling, flying, abrasive, and splashing objects, or exposed to harmful dusts, fumes, mists, vapors, or gases shall be provided with the particular personal protective equipment necessary to protect them from the hazard. All personal protective equipment shall meet the requirements and be maintained according to Subparts D and E of this part.

(d) *Switches.* (1) All hand-held powered platen sanders, grinders with wheels 2-inch diameter or less, routers, planers, laminate trimmers, nibblers, shears, scroll saws, and jigsaws with blade shanks one-fourth of an inch wide or less may be equipped with only a positive "on-off" control.

(2) All hand-held powered drills, tappers, fastener drivers, horizontal, vertical, and angle grinders with wheels greater than 2 inches in diameter, disc sanders, belt sanders, reciprocating saws, saber saws, and other similar operating powered tools shall be equipped with a momentary contact "on-off" control and may have a lock-on control provided that turnoff can be accomplished by a single motion of the same finger or fingers that turn it on.

(3) All other hand-held powered tools, such as circular saws, chain saws, and percussion tools without positive accessory holding means, shall be equipped with a constant pressure switch that will shut off the power when the pressure is released.

(4) The requirements of this paragraph shall become effective on July 15, 1972.

(5) Exception: This paragraph does not apply to concrete vibrators, concrete breakers, powered tampers, jack hammers, rock drills, and similar hand operated power tools.

The following requirements from 29 CFR Part 1910 (General Industry) have been identified as applicable to construction (29 CFR 1926.300 *General requirements* (Tools-Hand and Power)).

### § 1910.212 General requirements for all machines.

(a) *Machine guarding.* * * *

(3) *Point of operation guarding.* (i) Point of operation is the area on a machine where work is actually performed upon the material being processed.

(ii) The point of operation of machines whose operation exposes an employee to injury, shall be guarded. The guarding device shall be in conformity with any appropriate standards therefor, or, in the absence of applicable specific standards, shall be so designed and constructed as to prevent the operator from having any part of his body in the danger zone during the operating cycle.

(iii) Special handtools for placing and removing material shall be such as to permit easy handling of material without the operator placing a hand in the danger zone. Such tools shall not be in lieu of other guarding required by this section, but can only be used to supplement protection provided.

(iv) The following are some of the machines which usually require point of operation guarding:

(*a*) Guillotine cutters.
(*b*) Shears.
(*c*) Alligator shears.
(*d*) Power presses.
(*e*) Milling machines.
(*f*) Power saws.
(*g*) Jointers.
(*h*) Portable power tools.
(*i*) Forming rolls and calenders.

* * * * *

(5) *Exposure of blades.* When the periphery of the blades of a fan is less than seven (7) feet above the floor or working level, the blades shall be guarded. The guard shall have openings no larger than one half (½) inch.

* * * * *

(b) *Anchoring fixed machinery.* Machines designed for a fixed location shall be securely anchored to prevent walking or moving.

### § 1926.301 Hand tools.

(a) Employers shall not issue or permit the use of unsafe hand tools.

(b) Wrenches, including adjustable, pipe, end, and socket wrenches shall not be used when jaws are sprung to the point that slippage occurs.

(c) Impact tools, such as drift pins, wedges, and chisels, shall be kept free of mushroomed heads.

(d) The wooden handles of tools shall be kept free of splinters or cracks and shall be kept tight in the tool.

### § 1926.302 Power-operated hand tools.

(a) *Electric power-operated tools.* (1) Electric power operated tools shall either be of the approved double-insulated type or grounded in accordance with Subpart K of this part.

(2) The use of electric cords for hoisting or lowering tools shall not be permitted.

(b) *Pneumatic power tools.* (1) Pneumatic power tools shall be secured to the hose or whip by some positive means to prevent the tool from becoming accidentally disconnected.

(2) Safety clips or retainers shall be securely installed and maintained on

[1] Portions of the listed Part 1910 standards have been identified as applicable to construction.

pneumatic impact (percussion) tools to prevent attachments from being accidentally expelled.

(3) All pneumatically driven nailers, staplers, and other similar equipment provided with automatic fastener feed, which operate at more than 100 p.s.i. pressure at the tool shall have a safety device on the muzzle to prevent the tool from ejecting fasteners, unless the muzzle is in contact with the work surface.

(4) Compressed air shall not be used for cleaning purposes except where reduced to less than 30 p.s.i. and then only with effective chip guarding and personal protective equipment which meets the requirements of Subpart E of this part. The 30 p.s.i. requirement does not apply for concrete form, mill scale and similar cleaning purposes.

(5) The manufacturer's safe operating pressure for hoses, pipes, valves, filters, and other fittings shall not be exceeded.

(6) The use of hoses for hoisting or lowering tools shall not be permitted.

(7) All hoses exceeding ½-inch inside diameter shall have a safety device at the source of supply or branch line to reduce pressure in case of hose failure.

(8) Airless spray guns of the type which atomize paints and fluids at high pressures (1,000 pounds or more per square inch) shall be equipped with automatic or visible manual safety devices which will prevent pulling of the trigger to prevent release of the paint or fluid until the safety device is manually released.

(9) In lieu of the above, a diffuser nut which will prevent high pressure, high velocity release, while the nozzle tip is removed, plus a nozzle tip guard which will prevent the tip from coming into contact with the operator, or other equivalent protection, shall be provided.

(c) *Fuel powered tools.* (1) All fuel powered tools shall be stopped while being refueled, serviced, or maintained, and fuel shall be transported, handled, and stored in accordance with Subpart F of this part.

(2) When fuel powered tools are used in enclosed spaces, the applicable requirements for concentrations of toxic gases and use of personal protective equipment, as outlined in Subparts D and E of this part, shall apply.

(d) *Hydraulic power tools.* (1) The fluid used in hydraulic powered tools shall be fire-resistant fluids approved under Schedule 30 of the Bureau of Mines, U.S. Department of the Interior, and shall retain its operating characteristics at the most extreme temperatures to which it will be exposed.

(2) The manufacturer's safe operating pressures for hoses, valves, pipes, filters, and other fittings shall not be exceeded.

(e) *Powder-actuated tools.* (1) Only employees who have been trained in the operation of the particular tool in use shall be allowed to operate a powder-actuated tool.

(2) The tool shall be tested each day before loading to see that safety devices are in proper working condition. The method of testing shall be in accordance with the manufacturer's recommended procedure.

(3) Any tool found not in proper working order, or that develops a defect during use, shall be immediately removed from service and not used until properly repaired.

(4) Personal protective equipment shall be in accordance with Subpart E of this part.

(5) Tools shall not be loaded until just prior to the intended firing time. Neither loaded nor empty tools are to be pointed at any employees. Hands shall be kept clear of the open barrel end.

(6) Loaded tools shall not be left unattended.

(7) Fasteners shall not be driven into very hard or brittle materials including, but not limited to, cast iron, glazed tile, surface-hardened steel, glass block, live rock, face brick, or hollow tile.

(8) Driving into materials easily penetrated shall be avoided unless such materials are backed by a substance that will prevent the pin or fastener from passing completely through and creating a flying missile hazard on the other side.

(9) No fastener shall be driven into a spalled area caused by an unsatisfactory fastening.

(10) Tools shall not be used in an explosive or flammable atmosphere.

(11) All tools shall be used with the correct shield, guard, or attachment recommended by the manufacturer.

(12) Powder-actuated tools used by employees shall meet all other applicable requirements of American National Standards Institute, A10.3-1970, Safety Requirements for Explosive-Actuated Fastening Tools.

The following requirement from 29 CFR Part 1910 (General Industry) have been identified as applicable to construction (29 CFR 1926.302(b), Pneumatic power tools).

**§ 1910.244 Other Portable Tools and Equipment.**

* * * * *

(b) *Abrasive blast cleaning nozzles.* The blast cleaning nozzles shall be equipped with an operating valve which must be held open manually. A support shall be provided on which the nozzle may be mounted when it is not in use.

**§ 1926.303 Abrasive wheels and tools.**

(a) *Power.* All grinding machines shall be supplied with sufficient power to maintain the spindle speed at safe levels under all conditions of normal operation.

(b) *Guarding.* Grinding machines shall be equipped with safety guards in conformance with the requirements of American National Standards Institute, B7.1-1970, Safety Code for the Use, Care and Protection of Abrasive Wheels, and paragraph (d) of this section.

(c) *Use of abrasive wheels.* (1) Floor stand and bench mounted abrasive wheels, used for external grinding, shall be provided with safety guards (protection hoods). The maximum angular exposure of the grinding wheel periphery and sides shall be not more than 90°, except that when work requires contact with the wheel below the horizontal plane of the spindle, the angular exposure shall not exceed 125°. In either case, the exposure shall begin not more than 65° above the horizontal plane of the spindle. Safety guards shall be strong enough to withstand the effect of a bursting wheel.

(2) Floor and bench-mounted grinders shall be provided with work rests which are rigidly supported and readily adjustable. Such work rests shall be kept at a distance not to exceed one-eighth inch from the surface of the wheel.

(3) Cup type wheels used for external grinding shall be protected by either a revolving cup guard or a band type guard in accordance with the provisions of the American National Standards Institute, B7.1-1970 Safety Code for the Use, Care, and Protection of Abrasive Wheels. All other portable abrasive wheels used for external grinding, shall be provided with safety guards (protection hoods) meeting the requirements of subparagraph (5) of this paragraph, except as follows:

(i) When the work location makes it impossible, a wheel equipped with safety flanges, as described in subparagraph (6) of this paragraph, shall be used;

(ii) When wheels 2 inches or less in diameter which are securely mounted on the end of a steel mandrel are used.

(4) Portable abrasive wheels used for internal grinding shall be provided with safety flanges (protection flanges) meeting the requirements of subparagraph (6) of this paragraph, except as follows:

(i) When wheels 2 inches or less in diameter which are securely mounted on the end of a steel mandrel are used;

(ii) If the wheel is entirely within the work being ground while in use.

(5) When safety guards are required, they shall be so mounted as to maintain proper alignment with the wheel, and the guard and its fastenings shall

be of sufficient strength to retain fragments of the wheel in case of accidental breakage. The maximum angular exposure of the grinding wheel periphery and sides shall not exceed 180°.

(6) When safety flanges are required, they shall be used only with wheels designed to fit the flanges. Only safety flanges, of a type and design and properly assembled so as to ensure that the pieces of the wheel will be retained in case of accidental breakage, shall be used.

(7) All abrasive wheels shall be closely inspected and ring-tested before mounting to ensure that they are free from cracks or defects.

(8) Grinding wheels shall fit freely on the spindle and shall not be forced on. The spindle nut shall be tightened only enough to hold the wheel in place.

(9) All employees using abrasive wheels shall be protected by eye protection equipment in accordance with the requirements of Subpart E of this part, except when adequate eye protection is afforded by eye shields which are permanently attached to the bench or floor stand.

(d) *Other requirements.* All abrasive wheels and tools used by employees shall meet other applicable requirements of American National Standards Institute, B7.1-1970, Safety Code for the Use, Care and Protection of Abrasive Wheels.

**§ 1926.304 Woodworking tools.**

(a) *Disconnect switches.* All fixed power driven woodworking tools shall be provided with a disconnect switch that can either be locked or tagged in the off position.

(b) *Speeds.* The operating speed shall be etched or otherwise permanently marked on all circular saws over 20 inches in diameter or operating at over 10,000 peripheral feet per minute. Any saw so marked shall not be operated at a speed other than that marked on the blade. When a marked saw is retensioned for a different speed, the marking shall be corrected to show the new speed.

(c) *Self-feed.* Automatic feeding devices shall be installed on machines whenever the nature of the work will permit. Feeder attachments shall have the feed rolls or other moving parts covered or guarded so as to protect the operator from hazardous points.

(d) *Guarding.* All portable, power-driven circular saws shall be equipped with guards above and below the base plate or shoe. The upper guard shall cover the saw to the depth of the teeth, except for the minimum arc required to permit the base to be tilted for bevel cuts. The lower guard shall cover the saw to the depth of the teeth, except for the minimum arc required to allow proper retraction and contact with the work. When the tool is withdrawn from the work, the lower guard shall automatically and instantly return to the covering position.

(e) *Personal protective equipment.* All personal protective equipment provided for use shall conform to Subpart E of this part.

(f) *Other requirements.* All woodworking tools and machinery shall meet other applicable requirements of American National Standards Institute, 01.1-1961, Safety Code for Woodworking Machinery.

**§ 1926.305 Jacks—lever and ratchet, screw, and hydraulic.**

(a) *General requirements.* (1) The manufacturer's rated capacity shall be legibly marked on all jacks and shall not be exceeded.

(2) All jacks shall have a positive stop to prevent overtravel.

(b) *Lift slab construction.* (1) Hydraulic jacks used in lift slab construction shall have a safety device which will cause the jacks to support the load in any position in the event the jack malfunctions.

(2) If lift slabs are automatically controlled, a device shall be installed which will stop the operation when the ½-inch leveling tolerance is exceeded.

(c) *Blocking.* When it is necessary to provide a firm foundation, the base of the jack shall be blocked or cribbed. Where there is a possibility of slippage of the metal cap of the jack, a wood block shall be placed between the cap and the load.

The following requirements from 29 CFR Part 1910 (General Industry) have been identified as applicable to construction (29 CFR 1926.305. Jacks—lever and ratchet, screw, and hydraulic).

**§ 1910.244 Other portable tools and equipment.**

(a) *Jacks.* * * *

(2) *Operation and maintenance.* * * *

(iii) After the load has been raised, it shall be cribbed, blocked, or otherwise secured at once.

(iv) Hydraulic jacks exposed to freezing temperatures shall be supplied with an adequate antifreeze liquid.

(v) All jacks shall be properly lubricated at regular intervals. The lubricating instructions of the manufacturer should be followed, and only lubricants recommended by him should be used.

(vi) Each jack shall be thoroughly inspected at times which depend upon the service conditions. Inspections shall be not less frequent than the following:

(A) For constant or intermittent use at one locality, once every 6 months,

(B) For jacks sent out of shop for special work, when sent out and when returned,

(C) For a jack subjected to abnormal load or shock, immediately before and immediately thereafter.

(vii) Repair or replacement parts shall be examined for possible defects.

(viii) Jacks which are out of order shall be tagged accordingly, and shall not be used until repairs are made.

* * * * *

## Subpart J—Welding and Cutting

Sec.

1926.350 Gas welding and cutting.
1926.351 Arc Welding and cutting.
1926.352 Fire prevention.
1926.353 Ventilation and protection in welding, cutting, and heating.
1926.354 Welding, cutting and heating in way of preservative coatings.

**§ 1926.350 Gas welding and cutting.**

(a) *Transporting, moving, and storing compressed gas cylinders.* (1) Valve protection caps shall be in place and secured.

(2) When cylinders are hoisted, they shall be secured on a cradle, slingboard, or pallet. They shall not be hoisted or transported by means of magnets or choker slings.

(3) Cylinders shall be moved by tilting and rolling them on their bottom edges. They shall not be intentionally dropped, struck, or permitted to strike each other violently.

(4) When cylinders are transported by powered vehicles, they shall be secured in a vertical position.

(5) Valve protection caps shall not be used for lifting cylinders from one vertical position to another. Bars shall not be used under valves or valve protection caps to pry cylinders loose when frozen. Warm, not boiling, water shall be used to thaw cylinders loose.

(6) Unless cylinders are firmly secured on a special carrier intended for this purpose, regulators shall be removed and valve protection caps put in place before cylinders are moved.

(7) A suitable cylinder truck, chain, or other steadying device shall be used to keep cylinders from being knocked over while in use.

(8) When work is finished, when cylinders are empty, or when cylinders are moved at any time, the cylinder valve shall be closed.

(9) Compressed gas cylinders shall be secured in an upright position at all times except, if necessary, for short periods of time while cylinders are actually being hoisted or carried.

(b) *Placing cylinders.* (1) Cylinders shall be kept far enough away from the actual welding or cutting operation so that sparks, hot slag, or flame will not reach them. When this is impractical, fire resistant shields shall be provided.

(2) Cylinders shall be placed where they cannot become part of an electrical circuit. Electrodes shall not be struck against a cylinder to strike an arc.

(3) Fuel gas cylinders shall be placed with valve end up whenever they are in use. They shall not be placed in a location where they would be subject to open flame, hot metal, or other sources of artificial heat.

(4) Cylinders containing oxygen or acetylene or other fuel gas shall not be taken into confined spaces.

(c) *Treatment of cylinders.* (1) Cylinders, whether full or empty, shall not be used as rollers or supports.

(2) No person other than the gas supplier shall attempt to mix gases in a cylinder. No one except the owner of the cylinder or person authorized by him, shall refill a cylinder. No one shall use a cylinder's contents for purposes other than those intended by the supplier. All cylinders used shall meet the Department of Transportation requirements published in 49 CFR Part 178, Subpart C, Specification for Cylinders.

(3) No damaged or defective cylinder shall be used.

(d) *Use of fuel gas.* The employer shall thoroughly instruct employees in the safe use of fuel gas, as follows:

(1) Before a regulator to a cylinder valve is connected, the valve shall be opened slightly and closed immediately. (This action is generally termed "cracking" and is intended to clear the valve of dust or dirt that might otherwise enter the regulator.) The person cracking the valve shall stand to one side of the outlet, not in front of it. The valve of a fuel gas cylinder shall not be cracked where the gas would reach welding work, sparks, flame, or other possible sources of ignition.

(2) The cylinder valve shall always be opened slowly to prevent damage to the regulator. For quick closing, valves on fuel gas cylinders shall not be opened more than 1½ turns. When a special wrench is required, it shall be left in position on the stem of the valve while the cylinder is in use so that the fuel gas flow can be shut off quickly in case of an emergency. In the case of manifolded or coupled cylinders, at least one such wrench shall always be available for immediate use. Nothing shall be placed on top of a fuel gas cylinder, when in use, which may damage the safety device or interfere with the quick closing of the valve.

(3) Fuel gas shall not be used from cylinders through torches or other devices which are equipped with shutoff valves without reducing the pressure through a suitable regulator attached to the cylinder valve or manifold.

(4) Before a regulator is removed from a cylinder valve, the cylinder valve shall always be closed and the gas released from the regulator.

(5) If, when the valve on a fuel gas cylinder is opened, there is found to be a leak around the valve stem, the valve shall be closed and the gland nut tightened. If this action does not stop the leak, the use of the cylinder shall be discontinued, and it shall be properly tagged and removed from the work area. In the event that fuel gas should leak from the cylinder valve, rather than from the valve stem, and the gas cannot be shut off, the cylinder shall be properly tagged and removed from the work area. If a regulator attached to a cylinder valve will effectively stop a leak through the valve seat, the cylinder need not be removed from the work area.

(6) If a leak should develop at a fuse plug or other safety device, the cylinder shall be removed from the work area.

(e) *Fuel gas and oxygen manifolds.* (1) Fuel gas and oxygen manifolds shall bear the name of the substance they contain in letters at least 1-inch high which shall be either painted on the manifold or on a sign permanently attached to it.

(2) Fuel gas and oxygen manifolds shall be placed in safe, well ventilated, and accessible locations. They shall not be located within enclosed spaces.

(3) Manifold hose connections, including both ends of the supply hose that lead to the manifold, shall be such that the hose cannot be interchanged between fuel gas and oxygen manifolds and supply header connections. Adapters shall not be used to permit the interchange of hose. Hose connections shall be kept free of grease and oil.

(4) When not in use, manifold and header hose connections shall be capped.

(5) Nothing shall be placed on top of a manifold, when in use, which will damage the manifold or interfere with the quick closing of the valves.

(f) *Hose.* (1) Fuel gas hose and oxygen hose shall be easily distinguishable from each other. The contrast may be made by different colors or by surface characteristics readily distinguishable by the sense of touch. Oxygen and fuel gas hoses shall not be interchangeable. A single hose having more than one gas passage shall not be used.

(2) When parallel sections of oxygen and fuel gas hose are taped together, not more than 4 inches out of 12 inches shall be covered by tape.

(3) All hose in use, carrying acetylene, oxygen, natural or manufactured fuel gas, or any gas or substance which may ignite or enter into combustion, or be in any way harmful to employees, shall be inspected at the beginning of each working shift. Defective hose shall be removed from service.

(4) Hose which has been subject to flashback, or which shows evidence of severe wear or damage, shall be tested to twice the normal pressure to which it is subject, but in no case less than 300 p.s.i. Defective hose, or hose in doubtful condition, shall not be used.

(5) Hose couplings shall be of the type that cannot be unlocked or disconnected by means of a straight pull without rotary motion.

(6) Boxes used for the storage of gas hose shall be ventilated.

(7) Hoses, cables, and other equipment shall be kept clear of passageways, ladders and stairs.

(g) *Torches.* (1) Clogged torch tip openings shall be cleaned with suitable cleaning wires, drills, or other devices designed for such purpose.

(2) Torches in use shall be inspected at the beginning of each working shift for leaking shutoff valves, hose couplings, and tip connections. Defective torches shall not be used.

(3) Torches shall be lighted by friction lighters or other approved devices, and not by matches or from hot work.

(h) *Regulators and gauges.* Oxygen and fuel gas pressure regulators, including their related gauges, shall be in proper working order while in use.

(i) *Oil and grease hazards.* Oxygen cylinders and fittings shall be kept away from oil or grease. Cylinders, cylinder caps and valves, couplings, regulators, hose, and apparatus shall be kept free from oil or greasy substances and shall not be handled with oily hands or gloves. Oxygen shall not be directed at oily surfaces, greasy clothes, or within a fuel oil or other storage tank or vessel.

(j) *Additional rules.* For additional details not covered in this subpart, applicable technical portions of American National Standards Institute, Z49.1-1967, Safety in Welding and Cutting, shall apply.

**§ 1926.351 Arc welding and cutting.**

(a) *Manual electrode holders.* (1) Only manual electrode holders which are specifically designed for arc welding and cutting, and are of a capacity capable of safely handling the maximum rated current required by the electrodes, shall be used.

(2) Any current-carrying parts passing through the portion of the holder which the arc welder or cutter grips in his hand, and the outer surfaces of the

jaws of the holder, shall be fully insulated against the maximum voltage encountered to ground.

(b) *Welding cables and connectors.* (1) All arc welding and cutting cables shall be of the completely insulated, flexible type, capable of handling the maximum current requirements of the work in progress, taking into account the duty cycle under which the arc welder or cutter is working.

(2) Only cable free from repair or splices for a minimum distance of 10 feet from the cable end to which the electrode holder is connected shall be used, except that cables with standard insulated connectors or with splices whose insulating quality is equal to that of the cable are permitted.

(3) When it becomes necessary to connect or splice lengths of cable one to another, substantial insulated connectors of a capacity at least equivalent to that of the cable shall be used. If connections are effected by means of cable lugs, they shall be securely fastened together to give good electrical contact, and the exposed metal parts of the lugs shall be completely insulated.

(4) Cables in need of repair shall not be used. When a cable, other than the cable lead referred to in subparagraph (2) of this paragraph, becomes worn to the extent of exposing bare conductors, the portion thus exposed shall be protected by means of rubber and friction tape or other equivalent insulation.

(c) *Ground returns and machine grounding.* (1) A ground return cable shall have a safe current carrying capacity equal to or exceeding the specified maximum output capacity of the arc welding or cutting unit which it services. When a single ground return cable services more than one unit, its safe current-carrying capacity shall equal or exceed the total specified maximum output capacities of all the units which it services.

(2) Pipelines containing gases or flammable liquids, or conduits containing electrical circuits, shall not be used as a ground return. For welding on natural gas pipelines, the technical portions of regulations issued by the Department of Transportation, Office of Pipeline Safety, 49 CFR Part 192, Minimum Federal Safety Standards for Gas Pipelines, shall apply.

(3) When a structure or pipeline is employed as a ground return circuit, it shall be determined that the required electrical contact exists at all joints. The generation of an arc, sparks, or heat at any point shall cause rejection of the structures as a ground circuit.

(4) When a structure or pipeline is continuously employed as a ground return circuit, all joints shall be bonded, and periodic inspections shall be conducted to ensure that no condition of electrolysis or fire hazard exists by virtue of such use.

(5) The frames of all arc welding and cutting machines shall be grounded either through a third wire in the cable containing the circuit conductor or through a separate wire which is grounded at the source of the current. Grounding circuits, other than by means of the structure, shall be checked to ensure that the circuit between the ground and the grounded power conductor has resistance low enough to permit sufficient current to flow to cause the fuse or circuit breaker to interrupt the current.

(6) All ground connections shall be inspected to ensure that they are mechanically strong and electrically adequate for the required current.

(d) *Operating instructions.* Employers shall instruct employees in the safe means of arc welding and cutting as follows:

(1) When electrode holders are to be left unattended, the electrodes shall be removed and the holders shall be so placed or protected that they cannot make electrical contact with employees or conducting objects.

(2) Hot electrode holders shall not be dipped in water; to do so may expose the arc welder or cutter to electric shock.

(3) When the arc welder or cutter has occasion to leave his work or to stop work for any appreciable length of time, or when the arc welding or cutting machine is to be moved, the power supply switch to the equipment shall be opened.

(4) Any faulty or defective equipment shall be reported to the supervisor.

(5) Other requirements, as outlined in Article 630, National Electrical Code, NFPA 70-1971; ANSI C1-1971 (Rev. of 1968), Electric Welders, shall be used when applicable.

(e) *Shielding.* Whenever practicable, all arc welding and cutting operations shall be shielded by noncombustible or flameproof screens which will protect employees and other persons working in the vicinity from the direct rays of the arc.

**§ 1926.352 Fire prevention.**

(a) When practical, objects to be welded, cut, or heated shall be moved to a designated safe location or, if the objects to be welded, cut, or heated cannot be readily moved, all movable fire hazards in the vicinity shall be taken to a safe place, or otherwise protected.

(b) If the object to be welded, cut, or heated cannot be moved and if all the fire hazards cannot be removed, positive means shall be taken to confine the heat, sparks, and slag, and to protect the immovable fire hazards from them.

(c) No welding, cutting, or heating shall be done where the application of flammable paints, or the presence of other flammable compounds, or heavy dust concentrations creates a hazard.

(d) Suitable fire extinguishing equipment shall be immediately available in the work area and shall be maintained in a state of readiness for instant use.

(e) When the welding, cutting, or heating operation is such that normal fire prevention precautions are not sufficient, additional personnel shall be assigned to guard against fire while the actual welding, cutting, or heating operation is being performed, and for a sufficient period of time after completion of the work to ensure that no possibility of fire exists. Such personnel shall be instructed as to the specific anticipated fire hazards and how the firefighting equipment provided is to be used.

(f) When welding, cutting, or heating is performed on walls, floors, and ceilings, since direct penetration of sparks or heat transfer may introduce a fire hazard to an adjacent area, the same precautions shall be taken on the opposite side as are taken on the side on which the welding is being performed.

(g) For the elimination of possible fire in enclosed spaces as a result of gas escaping through leaking or improperly closed torch valves, the gas supply to the torch shall be positively shut off at some point outside the enclosed space whenever the torch is not to be used or whenever the torch is left unattended for a substantial period of time, such as during the lunch period. Overnight and at the change of shifts, the torch and hose shall be removed from the confined space. Open end fuel gas and oxygen hoses shall be immediately removed from enclosed spaces when they are disconnected from the torch or other gas-consuming device.

(h) Except when the contents are being removed or transferred, drums, pails, and other containers, which contain or have contained flammable liquids, shall be kept closed. Empty containers shall be removed to a safe area apart from hot work operations or open flames.

(i) Drums, containers, or hollow structures which have contained toxic or flammable substances shall, before welding, cutting, or heating is undertaken on them, either be filled with water or thoroughly cleaned of such substances and ventilated and tested. For welding, cutting and heating on steel pipelines containing natural gas, the pertinent portions of regulations issued by the Department of Transportation, Office of Pipeline Safety, 49 CFR Part 192, Minimum Federal Safety Standards for Gas Pipelines, shall apply.

(j) Before heat is applied to a drum, container, or hollow structure, a vent or opening shall be provided for the release of any built-up pressure during the application of heat.

**§ 1926.353 Ventilation and protection in welding, cutting, and heating.**

(a) *Mechanical ventilation.* For purposes of this section, mechanical ventilation shall meet the following requirements:

(1) Mechanical ventilation shall consist of either general mechanical ventilation systems or local exhaust systems.

(2) General mechanical ventilation shall be of sufficient capacity and so arranged as to produce the number of air changes necessary to maintain welding fumes and smoke within safe limits, as defined in Subpart D of this part.

(3) Local exhaust ventilation shall consist of freely movable hoods intended to be placed by the welder or burner as close as practicable to the work. This system shall be of sufficient capacity and so arranged as to remove fumes and smoke at the source and keep the concentration of them in the breathing zone within safe limits as defined in Subpart D of this part.

(4) Contaminated air exhausted from a working space shall be discharged into the open air or otherwise clear of the source of intake air.

(5) All air replacing that withdrawn shall be clean and respirable.

(6) Oxygen shall not be used for ventilation purposes, comfort cooling, blowing dust from clothing, or for cleaning the work area.

(b) *Welding, cutting, and heating in confined spaces.* (1) Except as provided in subparagraph (2) of this paragraph, and paragraph (c)(2) of this section, either general mechanical or local exhaust ventilation meeting the requirements of paragraph (a) of this section shall be provided whenever welding, cutting, or heating is performed in a confined space.

(2) When sufficient ventilation cannot be obtained without blocking the means of access, employees in the confined space shall be protected by air line respirators in accordance with the requirements of Subpart E of this part, and an employee on the outside of such a confined space shall be assigned to maintain communication with those working within it and to aid them in an emergency.

(c) *Welding, cutting, or heating of metals of toxic significance.* (1) Welding, cutting, or heating in any enclosed spaces involving the metals specified in this subparagraph shall be performed with either general mechanical or local exhaust ventilation meeting the requirements of paragraph (a) of this section:

(i) Zinc-bearing base or filler metals or metals coated with zinc-bearing materials;

(ii) Lead base metals;

(iii) Cadmium-bearing filler materials;

(iv) Chromium-bearing metals or metals coated with chromium-bearing materials.

(2) Welding, cutting, or heating in any enclosed spaces involving the metals specified in this subparagraph shall be performed with local exhaust ventilation in accordance with the requirements of paragraph (a) of this section, or employees shall be protected by air line respirators in accordance with the requirements of Subpart E of this part:

(i) Metals containing lead, other than as an impurity, or metals coated with lead-bearing materials;

(ii) Cadmium-bearing or cadmium-coated base metals;

(iii) Metals coated with mercury-bearing metals;

(iv) Beryllium-containing base or filler metals. Because of its high toxicity, work involving beryllium shall be done with both local exhaust ventilation and air line respirators.

(3) Employees performing such operations in the open air shall be protected by filter-type respirators in accordance with the requirements of Subpart E of this part, except that employees performing such operations on beryllium-containing base or filler metals shall be protected by air line respirators in accordance with the requirements of Subpart E of this part.

(4) Other employees exposed to the same atmosphere as the welders or burners shall be protected in the same manner as the welder or burner.

(d) *Inert-gas metal-arc welding.* (1) Since the inert-gas metal-arc welding process involves the production of ultra-violet radiation of intensities of 5 to 30 times that produced during shielded metal-arc welding, the decomposition of chlorinated solvents by ultraviolet rays, and the liberation of toxic fumes and gases, employees shall not be permitted to engage in, or be exposed to the process until the following special precautions have been taken:

(i) The use of chlorinated solvents shall be kept at least 200 feet, unless shielded, from the exposed arc, and surfaces prepared with chlorinated solvents shall be thoroughly dry before welding is permitted on such surfaces.

(ii) Employees in the area not protected from the arc by screening shall be protected by filter lenses meeting the requirements of Subpart E of this part. When two or more welders are exposed to each other's arc, filter lens goggles of a suitable type, meeting the requirements of Subpart E of this part, shall be worn under welding helmets. Hand shields to protect the welder against flashes and radiant energy shall be used when either the helmet is lifted or the shield is removed.

(iii) Welders and other employees who are exposed to radiation shall be suitably protected so that the skin is covered completely to prevent burns and other damage by ultraviolet rays. Welding helmets and hand shields shall be free of leaks and openings, and free of highly reflective surfaces.

(iv) When inert-gas metal-arc welding is being performed on stainless steel, the requirements of paragraph (c)(2) of this section shall be met to protect against dangerous concentrations of nitrogen dioxide.

(e) *General welding, cutting, and heating.* (1) Welding, cutting, and heating, not involving conditions or materials described in paragraph (b), (c), or (d) of this section, may normally be done without mechanical ventilation or respiratory protective equipment, but where, because of unusual physical or atmospheric conditions, an unsafe accumulation of contaminants exists, suitable mechanical ventilation or respiratory protective equipment shall be provided.

(2) Employees performing any type of welding, cutting, or heating shall be protected by suitable eye protective equipment in accordance with the requirements of Subpart E of this part.

**§ 1926.354 Welding, cutting, and heating in way of preservative coatings.**

(a) Before welding, cutting, or heating is commenced on any surface covered by a preservative coating whose flammability is not known, a test shall be made by a competent person to determine its flammability. Preservative coatings shall be considered to be highly flammable when scrapings burn with extreme rapidity.

(b) Precautions shall be taken to prevent ignition of highly flammable hardened preservative coatings. When coatings are determined to be highly flammable, they shall be stripped from the area to be heated to prevent ignition.

(c) Protection against toxic preservative coatings:

(1) In enclosed spaces, all surfaces covered with toxic preservatives shall be stripped of all toxic coatings for a distance of at least 4 inches from the area of heat application, or the employees shall be protected by air line respirators, meeting the requirements of Subpart E of this part.

(2) In the open air, employees shall be protected by a respirator, in accordance with requirements of Subpart E of this part.

(d) The preservative coatings shall be removed a sufficient distance from

the area to be heated to ensure that the temperature of the unstripped metal will not be appreciably raised. Artificial cooling of the metal surrounding the heating area may be used to limit the size of the area required to be cleaned.

### Subpart K—Electrical

Sec.
1926.400 General requirements.
1926.401 Grounding and bonding.
1926.402 Equipment installation and maintenance.
1926.403 Battery rooms and battery charging.
1926.404 Hazardous locations.
1926.405 Definitions applicable to this subpart.

### § 1926.400 General Requirements.

(a) All electrical work, installation, and wire capacities shall be in accordance with the pertinent provisions of the National Electrical Code, NFPA 70-1971; ANSI C1-1971 (Rev. of C1-1968), unless otherwise provided by regulations of this part.

(b) *Applicability.* These regulations apply only to electrical installations used on the jobsite, both temporary and permanent. For power distribution and transmission lines, see Subpart V of this part.

(c) *Protection of employees.* (1) No employer shall permit an employee to work in such proximity to any part of an electric power circuit that he may contact the same in the course of his work unless the employee is protected against electric shock by deenergizing the circuit and grounding it or by guarding it by effective insulation or other means. In work areas where the exact location of underground electric power lines is unknown, workmen using jack-hammers, bars, or other hand tools which may contact a line shall be provided with insulated protective gloves.

(2) Before work is begun the employer shall ascertain by inquiry or direct observation, or by instruments, whether any part of an electric power circuit, exposed or concealed, is so located that the performance of the work may bring any person, tool, or machine into physical or electrical contact therewith. The employer shall post and maintain proper warning signs where such a circuit exists. He shall advise his employees of the location of such lines, the hazards involved and the protective measures to be taken.

(d) *Passageways and open spaces.* Suitable barriers or other means shall be provided to ensure that workspace for electrical equipment will not be used as a passageway during periods when energized parts of electrical equipment are exposed.

(e) *Workspace around equipment.* Sufficient space shall be provided and maintained in the area of electrical equipment to permit ready and safe operation and maintenance of such equipment. When parts are exposed, the minimum clearance for the workspace shall be not less than 6¼ feet high, nor less than a radius of 3 feet wide, and there shall be clearance sufficient to permit at least a 90° opening of all doors or hinged panels. All working clearances shall be maintained in accordance with Article 110-16, National Electrical Code, NFPA 70-1971; ANSI C1-1971 (Rev. of C1-1968).

(f) *Load ratings.* In existing installations no changes in circuit protection shall be made to increase the load in excess of the load rating of the circuit wiring, as specified in National Electrical Code, NFPA 70-1971; ANSI C1-1971 (Rev. of C1-1968), Article 310.

(g) *Lockout and tagging of circuits.* (1) Equipment or circuits that are deenergized shall be rendered inoperative and have tags attached at all points where such equipment or circuits can be energized.

(2) Controls that are to be deactivated during the course of work on energized or deenergized equipment or circuits shall be tagged.

(3) Tags shall be placed to identify plainly the equipment or circuits being worked on.

(h) *Ground-fault protection*—(1) *General.* Notwithstanding any other provision of this part, the requirement in section 210-7 of the 1971 National Electrical Code (NFPA 70-1971; ANSI C1-1971) that all 15- and 20-ampere receptacle outlets on single-phase circuits for construction sites have approved ground-fault circuit protection for personnel does not apply. In lieu thereof, the employer shall use either ground-fault circuit interrupters as specified in paragraph (h)(2) of this section or an assured equipment grounding conductor program as specified in paragraph (h)(3) of this section, to protect employees on construction sites. These requirements are in addition to any other requirements for equipment grounding conductors.

(2) *Ground-fault circuit interrupters.* All 120-volt, single-phase, 15- and 20-ampere receptacle outlets on construction sites, which are not a part of the permanent wiring of the building or structure and which are in use by employees, shall have approved ground-fault circuit interrupters for personnel protection. Receptacles on a two-wire, single-phase portable or vehicle-mounted generator rated not more than 5kW, where the circuit conductors of the generator are insulated from the generator frame and all other grounded surfaces, need not be protected with ground-fault circuit interrupters.

(3) *Assured equipment grounding conductor program.* The employer shall establish and implement an assured equipment grounding conductor program on construction sites covering all cord sets, receptacles which are not a part of the permanent wiring of the building or structure, and equipment connected by cord and plug which are available for use or used by employees. This program shall comply with the following minimum requirements:

(i) A written description of the program, including the specific procedures adopted by the employer, shall be available at the jobsite for inspection and copying by the Assistant Secretary and any affected employee.

(ii) The employer shall designate one or more competent persons (as defined in § 1926.32(f)) to implement the program.

(iii) Each cord set, attachment cap, plug and receptacle of cord sets, and any equipment connected by cord and plug except cord sets and receptacles which are fixed and not exposed to damage, shall be visually inspected before each day's use for external defects, such as deformed or missing pins or insulation damage, and for indication of possible internal damage. Equipment found damaged or defective may not be used until repaired.

(iv) The following tests shall be performed on all cord sets, receptacles which are not a part of the permanent wiring of the building or structure, and cord- and plug-connected equipment required to be grounded:

(*a*) All equipment grounding conductors shall be tested for continuity and shall be electrically continuous.

(*b*) Each receptacle and attachment cap or plug shall be tested for correct attachment of the equipment grounding conductor. The equipment grounding conductor shall be connected to its proper terminal.

(v) All required tests shall be performed:

(*a*) Before first use;

(*b*) Before equipment is returned to service following any repairs;

(*c*) Before equipment is used after any incident which can be reasonably suspected to have caused damage (for example, when a cord set is run over); and

(*d*) At intervals not to exceed 3 months, except that cord sets and receptacles which are fixed and not exposed to damage shall be tested at intervals not exceeding 6 months.

(vi) The employer may not make available or permit the use by employees of any equipment which has not met the requirements of this paragraph (h)(3) of this section.

(vii) Tests performed as required in this paragraph shall be recorded. This test record shall identify each receptacle, cord set, and cord- and plug-connected equipment that passed the test, and shall indicate the last date it was

tested or the interval for which it was tested. This record shall be kept by means of logs, color coding, or other effective means, and shall be maintained until replaced by a more current record. The record shall be made available on the jobsite for inspection by the Assistant Secretary and any affected employee.

**§ 1926.401 Grounding and bonding.**

(a) *Portable and/or cord and plug-connected equipment.* (1) The noncurrent-carrying metal parts of portable and/or plug-connected equipment shall be grounded.

(2) Portable tools and appliances protected by an approved system of double insulation, or its equivalent, need not be grounded. Where such an approved system is employed, the equipment shall be distinctively marked.

(b) *Fixed equipment.* Exposed noncurrent-carrying metal parts of fixed electrical equipment, including motors, generators, frames and tracks of electrically operated cranes, electrically driven machinery, etc., shall be grounded.

(c) *Effective grounding.* The path from circuits, equipment, structures, and conduit or enclosures to ground shall be permanent and continuous; have ample carrying capacity to conduct safely the currents liable to be imposed on it; and have impedance sufficiently low to limit the potential above ground and to result in the operation of the overcurrent devices in the circuit.

(d) *Ground resistance.* Driven rod electrodes shall, where practicable, have a resistance to ground not to exceed 25 ohms. Where the resistance is not as low as 25 ohms, two or more electrodes connected in parallel shall be used.

(e) *Testing of grounds.* Grounding circuits shall be checked to ensure that the circuit between the ground and the grounded power conductor has a resistance which is low enough to permit sufficient current to flow to cause the fuse or circuit breaker to interrupt the current.

(f) *Extension cords.* Extension cords used with portable electric tools and appliances shall be of three-wire type.

(g) *Bonding.* (1) Conductors used for bonding and grounding stationary and movable equipment shall be of ample size to carry the anticipated current.

(2) When attaching bonding and grounding clamps or clips, a secure and positive metal-to-metal contact shall be made. Such attachments shall be made before closures are opened and material movements are started and shall not be broken until after material movements are stopped and closures are made.

(h) *Temporary wiring.* All temporary wiring shall be effectively grounded in accordance with the National Electrical Code, NFPA 70-1971; ANSI C1-1971 (Rev. of C1-1968), Articles 305 and 310.

(i) *Construction site.* Precautions shall be taken to make any necessary open wiring inaccessible to unauthorized personnel.

(j) *Temporary lighting.* (1) Temporary lights shall be equipped with guards to prevent accidental contact with the bulb, except that guards are not required when the construction of the reflector is such that the bulb is deeply recessed.

(2) Temporary lights shall be equipped with heavy duty electric cords with connections and insulation maintained in safe condition. Temporary lights shall not be suspended by their electric cords unless cords and lights are designed for this means of suspension. Splices shall have insulation equal to that of the cable.

(3) Working spaces, walkways, and similar locations shall be kept clear of cords so as not to create a hazard to employees.

(4) Portable electric lighting used in moist and/or other hazardous locations, as for example, drums, tanks, and vessels shall be operated at a maximum of 12 volts.

**§ 1926.402 Equipment installation and maintenance.**

(a) *Flexible cable and cords.* (1) Receptacles for attachment plugs shall be of approved, concealed contact type with a contact for extending ground continuity and shall be so designed and constructed that the plug may be pulled out without leaving any live parts exposed to accidental contact.

(2) Where different voltages, frequencies, or types of current (a.c. or d.c.) are to be supplied by portable cords, receptacles shall be of such design that attachment plugs used on such circuits are not interchangeable.

(3) Attachment plugs or other connectors supplying equipment at more than 300 volts shall be of the skirted type or otherwise so designed that arcs will be confined.

(4) Attachment plugs for use in work areas shall be so constructed that they will endure rough use and be equipped with a suitable cord grip to prevent strain on the terminal screws.

(5) Flexible cord shall be used only in continuous lengths without splice, except suitable molded or vulcanized splices may be used where properly made, and the insulation shall be equal to the cable being spliced and wire connections soldered.

(6) Trailing cables shall be protected from damage.

(7) Splices in trailing cable shall be mechanically strong components and insulated to retain the mechanical and dielectric strength of the original cable.

(8) Cable passing through work areas shall be covered or elevated to protect it from damage which would create a hazard to employees.

(9) Handlamps of the portable type shall be of the molded composition or other type approved for the purpose. Brass-shell, paper-lined lampholders shall not be used. Handlamps shall be equipped with a handle and a substantial guard over the bulb and attached to the lampholder or the handle.

(10) Worn or frayed electric cables shall not be used.

(11) Extension cords shall be protected against accidental damage as may be caused by traffic, sharp corners, or projections and pinching in doors or elsewhere.

(12) Extension cords shall not be fastened with staples, hung from nails, or suspended by wire.

(b) *Overcurrent protection.* (1) Overcurrent protection shall be provided by fuses or circuit breakers for each feeder and branch circuit, and shall be based on the current-carrying capacity of the conductors supplied and the power load being used.

(2) No overcurrent device shall be placed in any permanently grounded conductor, except where the overcurrent device simultaneously opens all conductors of the circuit or for motor running protection.

(3) When fuses are installed or removed with one or both terminals energized, special tools insulated for the voltage shall be used.

(c) *Switches, circuit breakers, and disconnecting means.* (1) Each disconnecting means for motors and appliances, and each service feeder or branch circuit at the point where it originates, shall be legibly marked to indicate its purpose unless located and arranged so the purpose is evident.

(2) Disconnecting means shall be located or shielded so that employees will not be injured.

(3) Boxes for disconnecting means shall be securely and rigidly fastened to the surface upon which they are mounted and fitted with covers.

(4) Boxes and disconnecting means installed in damp or wet locations shall be waterproof to the extent that water does not enter or accumulate.

(d) *Transformers.* (1) Energized transformers and other related electrically energized equipment over 150 volts to ground shall be protected so as to prevent accidental contact with any person. Protection shall be provided by individual integrated housing or by an enclosure, such as an electrical substation fence, which accommodates a group of such equipment. Metallic enclosures shall be grounded.

(2) Access to energized equipment covered by subparagraph (1) of this paragraph shall be secured by lock or other fasteners requiring the use of tools to open them.

(3) Signs indicating danger and prohibiting unauthorized access shall be conspicuously displayed on the housing or other enclosure around the equipment.

(4) Transformers mounted on utility poles at a height of more than 12 feet from the ground are exempt from the requirements of this paragraph.

(e) *Welding and cutting equipment.* Welding and cutting equipment shall meet the requirements specified in Subparts F and J of this part.

### § 1926.403 Battery rooms and battery charging.

(a) *General requirements.* (1) Batteries of the nonseal type shall be located in enclosures with outside vents or in well ventilated rooms, so arranged as to prevent the escape of fumes, gases, or electrolyte spray into other areas.

(2) Ventilation shall be provided to ensure diffusion of the gases from the battery to prevent the accumulation of an explosive mixture.

(3) Racks and trays shall be substantial and treated to be resistant to the electrolyte.

(4) Floors shall be of acid resistant construction or be protected from acid accumulations.

(5) Face shields, aprons, and rubber gloves shall be provided for workmen handling acids or batteries.

(6) Facilities for quick drenching of the eyes and body shall be provided within 25 feet of the work area for emergency use.

(7) Facilities shall be provided for flushing and neutralizing spilled electrolyte, for fire protection, for protecting charging apparatus from damage by trucks, and for adequate ventilation for dispersal of fumes from gassing batteries.

(b) *Charging.* (1) Battery charging installations shall be located in areas designated for that purpose.

(2) When charging batteries, the vent caps shall be kept in place to avoid electrolyte spray. Care shall be taken to assure that vent caps are functioning.

### § 1926.404 Hazardous locations.

(a) General: For the purpose of this section, hazardous locations are defined as follows:

(1) Class I Locations—Class I Locations are those in which flammable gases or vapors are or may be present in quantities sufficient to produce explosive or ignitable mixtures.

(2) Class II Locations—Class II Locations are those which are hazardous because of the presence of combustible dust.

(3) Class III Locations—Class III Locations are those which are hazardous because of the presence of easily ignitable fibers or flyings, but in which such fibers or flyings are not likely to be in suspension in air in quantities sufficient to produce ignitable mixtures.

(4) See the National Electrical Code, NFPA 70-1971; ANSI C1-1971 (Rev. of C1-1968) for further definition of divisions 1 and 2 for each class.

(b) All components and utilization equipment used in a hazardous location shall be chosen from among those listed by a nationally recognized testing laboratory, such as Underwriters' Laboratories, Inc., or Factory Mutual Engineering Corp., except custom-made components and utilization equipment.

(c) Equipment approved for a specific hazardous location shall not be installed or intermixed with equipment approved for another specific hazardous location.

(d) Employer shall ensure that all wiring components and utilization equipment are maintained as vapor, dust, or fiber tight as contemplated by their approvals. There shall be no loose or missing screws, gaskets, threaded connections, or other impairments to this tight condition.

### § 1926.405 Definitions applicable to this subpart.

(a) The definition of "approved" as set forth in § 1910.308(d) of this chapter shall apply.

(b) "Bonding jumper"—a conductor to assure the required electrical conductivity between metal parts required to be electrically connected.

(c) "Branch circuits"—that portion of a wiring system extending beyond the final overcurrent device protecting the circuit. (A device not approved for branch circuit protection, such as thermal cutout or motor overload protective device, is not considered as the overcurrent device protecting the circuit.)

(d) "Circuit breaker"—a device designed to open and close a circuit by manual means, and to open the circuit automatically on a predetermined overload of current, without injury to itself when properly applied within its rating.

(e) "Exposed" (as applied to live parts)—means that a live part can be inadvertently touched or approached nearer than a safe distance by a person. This term applies to parts not suitably guarded, isolated, or insulated.

(f) "Ground"—a conducting connection, whether intentional or accidental, between an electrical circuit or equipment and earth, or to some conducting body which serves in place of the earth.

(g) "Grounded"—connected to earth or to some conducting body which serves in place of the earth.

(h) "Hazard" is considered to include casualty, fire, and shock when applicable.

(i) "Isolated" means not readily accessible to person unless special means of access are used.

(j) "Raceway"—any channel for loosely holding wires or cables in interior work which is designed expressly and used solely for this purpose. Raceways may be of metal, wood, or insulating material, and the term includes wood and metal moldings consisting of a backing and capping, and also metal ducts into which wires are to be pulled.

(k) "Shock hazard"—considered to exist at an accessible part in a circuit between the part and ground, or other accessible parts if the potential is more than 42.4 volts peak and the current through a 1,500-ohm load is more than 5 milliamperes.

(l) "Weatherproof"—so constructed or protected that exposure to the weather shall not interfere with successful operation.

## Subpart L—Ladders and Scaffolding [1]

Sec.

1926.450 Ladders.
1926.451 Scaffolding.
*1910.21 Definitions.*
*1910.28 Scaffolds.*
*1910.29 Manually propelled mobile ladder stands.*
1926.452 Definitions applicable to this subpart.

### § 1926.450 Ladders.

(a) *General requirements.* (1) Except where either permanent or temporary stairways or suitable ramps or runways are provided, ladders described in this subpart shall be used to give safe access to all elevations.

(2) The use of ladders with broken or missing rungs or steps, broken or split side rails, or other faulty or defective construction is prohibited. When ladders with such defects are discovered, they shall be immediately withdrawn from service. Inspection of metal ladders shall include checking for corrosion of interiors of open end hollow rungs.

(3) Manufactured portable wood ladders provided by the employer shall be in accordance with the provisions of the American National Standards Institute, A 14.1-1968, Safety Code for Portable Wood Ladders.

(4) Portable metal ladders shall be of strength equivalent to that of wood ladders. Manufactured portable metal ladders provided by the employer shall be in accordance with the provisions of the American National Standards

[1] Portions of the listed Part 1910 standards have been identified as applicable to construction.

Institute, A 14.2-1956, Safety Code for Portable Metal Ladders.

(5) Fixed ladders shall be in accordance with the provisions of the American National Standards Institute, A 14.3-1956, Safety Code for Fixed Ladders.

(6) Portable ladder feet shall be placed on a substantial base, and the area around the top and bottom of the ladder shall be kept clear.

(7) Portable ladders shall be used at such a pitch that the horizontal distance from the top support to the foot of the ladder is about one-quarter of the working length of the ladder (the length along the ladder between the foot and the top support). Ladders shall not be used in a horizontal position as platforms, runways, or scaffolds.

(8) Ladders shall not be placed in passageways, doorways, driveways, or any location where they may be displaced by activities being conducted on any other work, unless protected by barricades or guards.

(9) The side rails shall extend not less than 36 inches above the landing. When this is not practical, grab rails, which provide a secure grip for an employee moving to or from the point of access, shall be installed.

(10) Portable ladders in use shall be tied, blocked, or otherwise secured to prevent their being displaced.

(11) Portable metal ladders shall not be used for electrical work or where they may contact electrical conductors.

(b) *Job-made ladders.* (1) Job-made ladders shall be constructed for intended use. If a ladder is to provide the only means of access or exit from a working area for 25 or more employees, or simultaneous two-way traffic is expected, a double cleat ladder shall be installed.

(2) Double cleat ladders shall not exceed 24 feet in length.

(3) Single cleat ladders shall not exceed 30 feet in length between supports (base and top landing). If ladders are to connect different landings, or if the length required exceeds this maximum length, two or more separate ladders shall be used, offset with a platform between each ladder. Guardrails and toeboards shall be erected on the exposed sides of the platforms. (See § 1926.451(a)(5).)

(4) The width of single cleat ladders shall be at least 15 inches, but not more than 20 inches, between rails at the top.

(5) Side rails shall be parallel or flared top to bottom by not more than one-quarter of an inch for each 2 feet of length.

(6) Wood side rails of ladders having cleats shall be not less than 1½ inches thick and 3½ inches deep (2 inches by 4 inches nominal) when made of Group 2 or Group 3 woods (see Table L-1). Wood side rails of Group 4 woods (see Table L-1) may be used in the same cross-section of dimensions for cleat ladders up to 20 feet in length.

TABLE L-1

AVERAGE DENSITIES OF VARIOUS SPECIES OF WOOD FOR USE IN LADDERS

| Species | Density (lbs./ft.³) |
|---|---|
| **GROUP 1** | |
| White ash | 41 |
| Beech | 43 |
| Birch | 44 |
| Rock elm | 43 |
| Hickory | 50 |
| Locust | 47 |
| Hard maple | 42 |
| Red maple | 36 |
| Red oak | 43 |
| White oak | 46 |
| Pecan | 46 |
| Persimmon | 50 |
| **GROUP 2** | |
| Douglas fir (coast region) | 34 |
| Western larch | 38 |
| Southern yellow pine | 37 |
| **GROUP 3** | |
| Red alder | 28 |
| Oregon ash | 38 |
| Pumpkin ash | 37 |
| Alaska cedar | 31 |
| Port Orford cedar | 30 |
| Cucumber | 34 |
| Cypress | 32 |
| Soft elm | 36 |
| Douglas fir (Rocky Mountain type) | 30 |
| Noble fir | 27 |
| Gum | 34 |
| West Coast hemlock | 30 |
| Magnolia | 35 |
| Oregon maple | 34 |
| Norway pine | 31 |
| Poplar | 28 |
| Redwood | 25 |
| Eastern spruce | 28 |
| Sitka spruce | 28 |
| Sycamore | 35 |
| Tamarack | 37 |
| Tupelo | 35 |
| **GROUP 4** | |
| Aspen | 27 |
| Basswood | 25 |
| Buckeye | 25 |
| Butternut | 27 |
| Incense cedar | 25 |
| Western red cedar | 23 |
| Black cottonwood | 24 |
| White fir | 26 |
| Hackberry | 37 |
| Eastern hemlock | 28 |
| Holly | 39 |
| Soft maple | 33 |
| Lodgepole pine | 29 |
| Idaho white pine | 28 |
| Northern white pine | 25 |
| Ponderosa pine | 28 |
| Sugar pine | 26 |

(7) It is preferable that side rails be continuous. If splicing is necessary to attain the required length, however, the splice must develop the full strength of a continuous side rail of the same length.

(8) 2-inch by 4-inch lumber shall be used for side rails of single cleat ladders up to 16 feet long; 3-inch by 6-inch lumber shall be used for single cleat ladders from 16 to 30 feet in length.

(9) 2-inch by 4-inch lumber shall be used for side and middle rails of double cleat ladders up to 12 feet in length; 2-inch by 6-inch lumber for double cleat ladders from 12 to 24 feet in length.

(10) Wood cleats shall have the following minimum dimensions when made of Group 1 woods (see Table L-1):

TABLE L-2

| Length of cleat (inches) | Thickness (inches) | Width (inches) |
|---|---|---|
| Up to and including 20 | ¾ | 3 |
| Over 20 and up to and including 30 | ¾ | 3¾ |

(11) Cleats may be made of species of any other group of wood (see Table L-1) provided equal or greater strength is maintained.

(12) Cleats shall be inset into the edges of the side rails one-half inch, or filler blocks shall be used on the rails between the cleats. The cleats shall be secured to each rail with three 10d common wire nails or other fasteners of equivalent strength. Cleats shall be uniformly spaced, 12 inches top-to-top.

**§ 1926.451 Scaffolding.**

(a) *General requirements.* (1) Scaffolds shall be erected in accordance with requirements of this section.

(2) The footing or anchorage for scaffolds shall be sound, rigid, and capable of carrying the maximum intended load without settling or displacement. Unstable objects such as barrels, boxes, loose brick, or concrete blocks, shall not be used to support scaffolds or planks.

(3) No scaffold shall be erected, moved, dismantled, or altered except under the supervision of competent persons.

(4) Guardrails and toeboards shall be installed on all open sides and ends of platforms more than 10 feet above the ground or floor, except needle beam scaffolds and floats (see paragraphs (p) and (w) of this section). Scaffolds 4 feet to 10 feet in height, having a minimum horizontal dimension in either direction of less than 45 inches, shall have standard guardrails installed on all open sides and ends of the platform.

(5) Guardrails shall be 2 x 4 inches, or the equivalent, approximately 42 inches high, with a midrail, when required. Supports shall be at intervals not to exceed 8 feet. Toeboards shall be a minimum of 4 inches in height.

(6) Where persons are required to work or pass under the scaffold, scaffolds shall be provided with a screen between the toeboard and the guardrail, extending along the entire open-

ing, consisting of No. 18 gauge U.S. Standard wire ½-inch mesh, or the equivalent.

(7) Scaffolds and their components shall be capable of supporting without failure at least 4 times the maximum intended load.

(8) Any scaffold including accessories such as braces, brackets, trusses, screw legs, ladders, etc. damaged or weakened from any cause shall be immediately repaired or replaced.

(9) All load-carrying timber members of scaffold framing shall be a minimum of 1,500 fiber (Stress Grade) construction grade lumber. All dimensions are nominal sizes as provided in the American Lumber Standards, except that where rough sizes are noted, only rough or undressed lumber of the size specified will satisfy minimum requirements.

(10) All planking shall be Scaffold Grades, or equivalent, as recognized by approved grading rules for the species of wood used. The maximum permissible spans for 2- x 10-inch or wider planks shall be as shown in the following:

TABLE L–3

MATERIAL

| | Full thickness undressed lumber | | | Nominal thickness lumber[1] | |
|---|---|---|---|---|---|
| Working load (p.s.f.) | 25 | 50 | 75 | 25 | 50 |
| Permissible span (ft.) | 10 | 8 | 6 | 8 | 6 |

[1] Nominal thickness lumber not recommended for heavy duty use.

(11) The maximum permissible span for 1¼- x 9-inch or wider plank of full thickness shall be 4 feet with medium duty loading of 50 p.s.f.

(12) All planking or platforms shall be overlapped (minimum 12 inches), or secured from movement.

(13) An access ladder or equivalent safe access shall be provided.

(14) Scaffold planks shall extend over their end supports not less than 6 inches nor more than 12 inches.

(15) The poles, legs, or uprights of scaffolds shall be plumb, and securely and rigidly braced to prevent swaying and displacement.

(16) Overhead protection shall be provided for men on a scaffold exposed to overhead hazards.

(17) Slippery conditions on scaffolds shall be eliminated as soon as possible after they occur.

(18) No welding, burning, riveting, or open flame work shall be performed on any staging suspended by means of fiber or synthetic rope. Only treated or protected fiber or synthetic ropes shall be used for or near any work involving the use of corrosive substances or chemicals. Specific requirements for boatswain's chairs and float or ship scaffolds are contained in paragraphs (l) and (w) of this section.

(19) Wire, synthetic, or fiber rope used for scaffold suspension shall be capable of supporting at least 6 times the rated load.

(20) The use of shore or lean-to scaffolds is prohibited.

(21) Lumber sizes, when used in this subpart, refer to nominal sizes except where otherwise stated.

(b) *Wood pole scaffolds.* (1) Scaffold poles shall bear on a foundation of sufficient size and strength to spread the load from the pole over a sufficient area to prevent settlement. All poles shall be set plumb.

(2) Where wood poles are spliced, the ends shall be squared and the upper section shall rest squarely on the lower section. Wood splice plates shall be provided on at least two adjacent sides and shall be not less than 4 feet in length, overlapping the abutted ends equally, and have the same width and not less than the cross-sectional area of the pole. Splice plates or other materials of equivalent strength may be used.

(3) Independent pole scaffolds shall be set as near to the wall of the building as practicable.

(4) All pole scaffolds shall be securely guyed or tied to the building or structure. Where the height or length exceeds 25 feet, the scaffold shall be secured at intervals not greater than 25 feet vertically and horizontally.

(5) Putlogs or bearers shall be set with their greater dimension vertical, long enough to project over the ledgers of the inner and outer rows of poles at least 3 inches for proper support.

(6) Every wooden putlog on single pole scaffolds shall be reinforced with a 3/16- x 2-inch steel strip, or equivalent, secured to its lower edge throughout its entire length.

(7) Ledgers shall be long enough to extend over two pole spaces. Ledgers shall not be spliced between the poles. Ledgers shall be reinforced by bearing blocks securely nailed to the side of the pole to form a support for the ledger.

(8) Diagonal bracing shall be provided to prevent the poles from moving in a direction parallel with the wall of the building, or from buckling.

(9) Cross bracing shall be provided between the inner and outer sets of poles in independent pole scaffolds. The free ends of pole scaffolds shall be cross braced.

(10) Full diagonal face bracing shall be erected across the entire face of pole scaffolds in both directions. The braces shall be spliced at the poles. The inner row of poles on medium and heavy duty scaffolds shall be braced in a similar manner.

(11) Platform planks shall be laid with their edges close together so the platform will be tight with no spaces through which tools or fragments of material can fall.

(12) Where planking is lapped, each plank shall lap its end supports at least 12 inches. Where the ends of planks abut each other to form a flush floor, the butt joint shall be at the centerline of a pole. The abutted ends shall rest on separate bearers. Intermediate beams shall be provided where necessary to prevent dislodgment of planks due to deflection, and the ends shall be secured to prevent their dislodgment.

(13) When a scaffold materially changes its direction, the platform planks shall be laid to prevent tipping. The planks that meet the corner putlog at an angle shall be laid first, extending over the diagonally placed putlog far enough to have a good safe bearing, but not far enough to involve any danger from tipping. The planking running in the opposite direction at an angle shall be laid so as to extend over and rest on the first layer of planking.

(14) When moving platforms to the next level, the old platform shall be left undisturbed until the new putlogs or bearers have been set in place, ready to receive the platform planks.

(15) Guardrails, made of lumber not less than 2 x 4 inches (or other material providing equivalent protection), approximately 42 inches high, with a midrail of 1 x 6 inch lumber (or other material providing equivalent protection), and toeboards, shall be installed at all open sides and ends on all scaffolds more than 10 feet above the ground or floor. Toeboards shall be a minimum of 4 inches in height. Wire mesh shall be installed in accordance with paragraph (a)(6) of this section, when required.

(16) All wood pole scaffolds 60 feet or less in height shall be constructed and erected in accordance with Tables L–4 to 10. If they are over 60 feet in height, they shall be designed by a qualified engineer competent in this field, and it shall be constructed and erected in accordance with such design.

TABLE L-4—MINIMUM NOMINAL SIZE AND MAXIMUM SPACING OF MEMBERS OF SINGLE POLE SCAFFOLDS, LIGHT DUTY

| | Maximum height of scaffold | |
|---|---|---|
| | 20 ft. | 60 ft. |
| Uniformly distributed load | Not to exceed 25 p.s.f. | |
| Poles or uprights | 2x4 in | 4x4 in. |
| Pole spacing (longitudinal) | 6 ft. 0 in | 10 ft. 0 in. |
| Maximum width of scaffold | 5 ft. 0 in | 5 ft. 0 in. |
| Bearers or putlogs to 3 ft. 0 in. width | 2x4 in | 2x4 in. |
| Bearers or putlogs to 5 ft. 0 in. width | 2x6 in. or 3x4 in | 2x6 in. or 3x4 in. (rough). |
| Ledgers | 1x4 in | 1¼x9 in. |
| Planking | 1¼x9 in. (rough) | 2x10 in. |
| Vertical spacing of horizontal members | 7 ft. 0 in | 9 ft. 0 in. |
| Bracing, horizontal and diagonal | 1x4 in | 1x4 in. |
| Tie-ins | 1x4 in | 1x4 in. |
| Toeboards | 4 in. high (minimum) | 4 in. high (minimum). |
| Guardrail | 2x4 in | 2x4 in. |

All members except planking are used on edge.

TABLE L-5—MINIMUM NOMINAL SIZE AND MAXIMUM SPACING OF MEMBERS OF SINGLE POLE SCAFFOLDS—MEDIUM DUTY

| | |
|---|---|
| Uniformly distributed load. | Not to exceed 50 p.s.f. |
| Maximum height of scaffold. | 60 ft. |
| Poles or uprights | 4x4 in. |
| Pole spacing (longitudinal) | 8 ft. 0 in. |
| Maximum width of scaffold | 5 ft. 0 in. |
| Bearers or putlogs | 2x10 in. or 3x4 in. |
| Spacing of bearers or putlogs. | 8 ft. 0 in. |
| Ledgers | 2x10 in. |
| Vertical spacing of horizontal members. | 7 ft. 0 in. |
| Bracing, horizontal | 1x6 in. or 1¼x4 in. |
| Bracing, diagonal | 1x4 in. |
| Tie-ins | 1x4 in. |
| Planking | 2x10 in. |
| Toeboards | 4-in. high (minimum). |
| Guardrail | 2x4 in. |

All members except planking are used on edge.

TABLE L-6—MINIMUM NOMINAL SIZE AND MAXIMUM SPACING OF MEMBERS OF SINGLE POLE SCAFFOLDS—HEAVY DUTY

| | |
|---|---|
| Uniformly distributed load | Not to exceed 75 p.s.f. |
| Maximum height of scaffold. | 60 ft. |
| Poles or uprights | 4x6 in. |
| Pole spacing (longitudinal) | 6 ft. 0 in. |
| Maximum width of scaffold | 5 ft. 0 in. |
| Bearers or putlogs | 2x10 in. or 3x5 in. |
| Spacing of bearers or putlog. | 6 ft. 0 in. |
| Ledgers | 2x10 in. |
| Vertical spacing of horizontal members. | 6 ft. 6 in. |
| Bracing, horizontal and diagonal. | 2x4 in. |
| Tie-ins | 1x4 in. |
| Planking | 2x10 in. |
| Toeboards | 4-in. high (minimum). |
| Guardrail | 2x4 in. |

All members except planking are used on edge.

TABLE L-7—MINIMUM NOMINAL SIZE AND MAXIMUM SPACING OF MEMBERS OF INDEPENDENT POLE SCAFFOLD—LIGHT DUTY

| | Maximum height of scaffold | |
|---|---|---|
| | 20 ft. | 60 ft. |
| Uniformly distributed load | Not to exceed 25 p.s.f. | |
| Poles or uprights | 2x4 in | 4x4 in. |
| Pole spacing (longitudinal) | 6 ft. 0 in | 10 ft. 0 in. |
| Pole spacing (transverse) | 6 ft. 0 in | 10 ft. 0 in. |
| Ledgers | 1¼x4 in | 1¼x9 in. |
| Bearers to 3 ft. 0 in. span | 2x4 in | 2x4 in. |
| Bearers to 10 ft. 0 in. span | 2x6 in. or 3x4 in | 2x10 (rough) or 3x8 in. |
| Planking | 1¼x9 in | 2x10 in. |
| Vertical spacing of horizontal members | 7 ft. 0 in | 7 ft. 0 in. |
| Bracing, horizontal and diagonal | 1x4 in | 1x4 in. |
| Tie-ins | 1x4 in | 1x4 in. |
| Toeboards | 4 in. high | 4 in. high (minimum) |
| Guardrail | 2x4 in | 2x4 in. |

All members except planking are used on edge.

TABLE L-8—MINIMUM NOMINAL SIZE AND MAXIMUM SPACING OF MEMBERS OF INDEPENDENT POLE SCAFFOLDS—MEDIUM DUTY

| | |
|---|---|
| Uniformly distributed load. | Not to exceed 50 p.s.f. |
| Maximum height of scaffold. | 60 ft. |
| Poles or uprights | 4x4 in. |
| Pole spacing (longitudinal) | 8 ft. 0 in. |
| Pole spacing (transverse) | 8 ft. 0 in. |
| Ledgers | 2x10 in. |
| Vertical spacing of horizontal members. | 6 ft. 0 in. |
| Spacing of bearers | 8 ft. 0 in. |
| Bearers | 2x10 in. |
| Bracing, horizontal | 1x6 in. or 1¼x4 in. |
| Bracing, diagonal | 1x4 in. |
| Tie-ins | 1x4 in. |
| Planking | 2x10 in. |
| Toeboards | 4-in. high (minimum). |
| Guardrail | 2x4 in. |

All members except planking are used on edge.

TABLE L-9—MINIMUM NOMINAL SIZE AND MAXIMUM SPACING OF MEMBERS OF INDEPENDENT POLE SCAFFOLDS—HEAVY DUTY

| | |
|---|---|
| Uniformly distributed load. | Not to exceed 75 p.s.f. |
| Maximum height of scaffold. | 60 ft. |
| Poles or uprights | 4x4 in. |
| Pole spacing (longitudinal) | 6 ft. 0 in. |
| Pole spacing (transverse) | 8 ft. 0 in. |
| Ledgers | 2x10 in. |
| Vertical spacing of horizontal members. | 6 ft. 0 in. |
| Bearers | 2x10 in. (rough). |
| Bracing, horizontal and diagonal. | 2x4 in. |
| Tie-ins | 1x4 in. |
| Planking | 2x10 in. |
| Toeboards | 4-in. high (minimum). |
| Guardrail | 2x4 in. |

All members except planking are used on edge.

(c) *Tube and coupler scaffolds.* (1) A light duty tube and coupler scaffold shall have all posts, bearers, runners, and bracing of nominal 2-inch O.D. steel tubing. The posts shall be spaced no more than 6 feet apart by 10 feet along the length of the scaffold. Other structural metals when used must be designed to carry an equivalent load. No dissimilar metals shall be used together.

(2) A medium duty tube and coupler scaffold shall have all posts, runners, and bracing of nominal 2-inch O.D. steel tubing. Posts spaced not more than 6 feet apart by 8 feet along the length of the scaffold shall have bearers of nominal 2½-inch O.D. steel tubing. Posts spaced not more than 5 feet apart by 8 feet along the length of the scaffold shall have bearers of nominal 2-inch O.D. steel tubing. Other structural metals, when used, must be designed to carry an equivalent load. No dissimilar metals shall be used together.

(3) A heavy duty tube and coupler scaffold shall have all posts, runners, and bracing of nominal 2-inch O.D. steel tubing, with the posts spaced not more than 6 feet by 6 feet-6 inches. Other structural metals, when used, must be designed to carry an equivalent load. No dissimilar metals shall be used together.

(4) Tube and coupler scaffolds shall be limited in heights and working levels to those permitted in Tables L-10, 11, and 12. Drawings and specifications of all tube and coupler scaffolds above the limitations in Tables L-10, 11, and 12 shall be designed by a qualified engineer competent in this field.

(5) All tube and coupler scaffolds shall be constructed and erected to support four times the maximum intended loads, as set forth in Tables L-10, 11, and 12, or as set forth in the specifications by a licensed professional engineer competent in this field.

TABLE L-10—TUBE AND COUPLER SCAFFOLDS—LIGHT DUTY

| | |
|---|---|
| Uniformly distributed load | Not to exceed 25 p.s.f. |
| Post spacing (longitudinal) | 10 ft. 0 in. |
| Post spacing (transverse) | 6 ft. 0 in. |

| Working levels | Additional planked levels | Maximum height |
|---|---|---|
| 1 | 8 | 125 ft. |
| 2 | 4 | 125 ft. |
| 3 | 0 | 91 ft. 0 in. |

TABLE L-11—TUBE AND COUPLER SCAFFOLDS—MEDIUM DUTY

| | |
|---|---|
| Uniformly distributed load | Not to exceed 50 p.s.f. |
| Post spacing (longitudinal) | 8 ft. 0 in. |
| Post spacing (transverse) | 6 ft. 0 in. |

| Working levels | Additional planked levels | Maximum height |
|---|---|---|
| 1 | 6 | 125 ft. |
| 2 | 0 | 78 ft. 0 in. |

TABLE L-12—TUBE AND COUPLER SCAFFOLDS—HEAVY DUTY

| | |
|---|---|
| Uniformly distributed load | Not to exceed 75 p.s.f. |
| Post spacing (longitudinal) | 6 ft. 6 in. |
| Post spacing (transverse) | 6 ft. 0 in. |

| Working levels | Additional planked levels | Maximum height |
|---|---|---|
| 1 | 6 | 125 ft. |

(6) Posts shall be accurately spaced, erected on suitable bases, and maintained plumb.

(7) Runners shall be erected along the length of the scaffold, located on both the inside and the outside posts at even height. Runners shall be interlocked to the inside and the outside posts at even heights. Runners shall be interlocked to form continuous lengths and coupled to each post. The bottom runners shall be located as close to the base as possible. Runners shall be placed not more than 6 feet-6 inches on centers.

(8) Bearers shall be installed transversely between posts and shall be securely coupled to the posts bearing on the runner coupler. When coupled directly to the runners, the coupler must be kept as close to the posts as possible.

(9) Bearers shall be at least 4 inches but not more than 12 inches longer than the post spacing or runner spacing.

(10) Cross bracing shall be installed across the width of the scaffold at least every third set of posts horizontally and every fourth runner vertically. Such bracing shall extend diagonally from the inner and outer runners upward to the next outer and inner runners.

(11) Longitudinal diagonal bracing on the inner and outer rows of poles shall be installed at approximately a 45° angle from near the base of the first outer post upward to the extreme top of the scaffold. Where the longitudinal length of the scaffold permits, such bracing shall be duplicated beginning at every fifth post. In a similar manner, longitudinal diagonal bracing shall also be installed from the last post extending back and upward toward the first post. Where conditions preclude the attachment of this bracing to the posts, it may be attached to the runners.

(12) The entire scaffold shall be tied to and securely braced against the building at intervals not to exceed 30 feet horizontally and 26 feet vertically.

(13) Guardrails, made of lumber not less than 2×4 inches (or other material providing equivalent protection), approximately 42 inches high, with a midrail of 1×6 inch lumber (or other material providing equivalent protection), and toeboard shall be installed at all open sides and ends on all scaffolds more than 10 feet above the ground or floor. Toeboards shall be a minimum of 4 inches in height. Wire mesh shall be installed in accordance with paragraph (a)(6) of this section.

(d) *Tubular welded frame scaffolds.* (1) Metal tubular frame scaffolds, including accessories such as braces, brackets, trusses, screw legs, ladders, etc., shall be designed, constructed, and erected to safely support four times the maximum rated load.

(2) Spacing of panels or frames shall be consistent with the loads imposed.

(3) Scaffolds shall be properly braced by cross bracing or diagonal braces, or both, for securing vertical members together laterally, and the cross braces shall be of such length as will automatically square and aline vertical members so that the erected scaffold is always plumb, square, and rigid. All brace connections shall be made secure.

(4) Scaffold legs shall be set on adjustable bases or plain bases placed on mud sills or other foundations adequate to support the maximum rated load.

(5) The frames shall be placed one on top of the other with coupling or stacking pins to provide proper vertical alinement of the legs.

(6) Where uplift may occur, panels shall be locked together vertically by pins or other equivalent suitable means.

(7) To prevent movement, the scaffold shall be secured to the building or structure at intervals not to exceed 30 feet horizontally and 26 feet vertically.

(8) Maximum permissible spans or planking shall be in conformity with paragraph (a)(10) of this section.

(9) Drawings and specifications for all frame scaffolds over 125 feet in height above the base plates shall be designed by a registered professional engineer.

(10) Guardrails made of lumber, not less than 2×4 inches (or other material providing equivalent protection), and approximately 42 inches high, with a midrail of 1×6 inch lumber (or other material providing equivalent protection), and toeboards, shall be installed at all open sides and ends on all scaffolds more than 10 feet above the ground or floor. Toeboards shall be a minimum of 4 inches in height. Wire mesh shall be installed in accordance with paragraph (a)(6) of this section.

(e) *Manually propelled mobile scaffolds.* (1) When free-standing mobile scaffold towers are used, the height shall not exceed four times the minimum base dimension.

(2) Casters shall be properly designed for strength and dimensions to support four times the maximum intended load. All casters shall be provided with a positive locking device to hold the scaffold in position.

(3) Scaffolds shall be properly braced by cross bracing and horizontal bracing conforming with paragraph (d)(3) of this section.

(4) Platforms shall be tightly planked for the full width of the scaffold except for necessary entrance opening. Platforms shall be secured in place.

(5) A ladder or stairway shall be provided for proper access and exit and shall be affixed or built into the scaffold and so located that when in use it will not have a tendency to tip the scaffold. A landing platform must be provided at intervals not to exceed 35 feet.

(6) The force necessary to move the mobile scaffold shall be applied near or as close to the base as practicable and provision shall be made to stabilize the tower during movement from one location to another. Scaffolds shall only be moved on level floors, free of obstructions and openings.

(7) The employer shall not allow employees to ride on manually propelled scaffolds unless the following conditions exist:

(i) The floor or surface is within 3° of level, and free from pits, holes, or obstructions;

(ii) The minimum dimension of the scaffold base when ready for rolling, is at least one-half of the height. Outriggers, if used, shall be installed on both sides of staging;

(iii) The wheels are equipped with rubber or similar resilient tires;

(iv) All tools and materials are secured or removed from the platform before the mobile scaffold is moved.

(8) Scaffolds in use by any persons shall rest upon a suitable footing and shall stand plumb. The casters or wheels shall be locked to prevent any movement.

(9) Mobile scaffolds constructed of metal members shall also conform to applicable provisions of paragraphs (b), (c), or (d) of this section, depending on the material of which they are constructed.

(10) Guardrails made of lumber, not less than 2×4 inches (or other material providing equivalent protection), approximately 42 inches high, with a midrail, of 1×6 inch lumber (or other material providing equivalent protection), and toeboards, shall be installed at all open sides and ends on all scaffolds more than 10 feet above the ground or floor. Toeboards shall be a minimum of 4 inches in height. Wire mesh shall be installed in accordance with paragraph (a)(6) of this section.

(f) *Elevating and rotating work platforms.* Applicable requirements of American National Standards Institute A92.2-1969, Vehicle Mounted Elevating and Rotating Work Platforms, shall be complied with for such equipment, as required by the provisions of § 1926.556.

(g) *Outrigger scaffolds.* (1) Outrigger beams shall extend not more than 6 feet beyond the face of the building. The inboard end of outrigger beams, measured from the fulcrum point to anchorage point, shall be not less than 1½ times the outboard end in length. The beams shall rest on edge, the sides shall be plumb, and the edges shall be horizontal. The fulcrum point of the beam shall rest on a secure bearing at least 6 inches in each horizontal dimension. The beam shall be secured in place against movement and shall be securely braced at the fulcrum point against tipping.

(2) The inboard ends of outrigger beams shall be securely anchored either by means of struts bearing against sills in contact with the overhead beams or ceiling, or by means of tension members secured to the floor joists underfoot, or by both if necessary. The inboard ends of outrigger beams shall be secured against tipping and the entire supporting structure shall be securely braced in both directions to prevent any horizontal movement.

(3) Unless outrigger scaffolds are designed by a registered professional engineer competent in this field, they shall be constructed and erected in accordance with Table L-13. Outrigger scaffolds, designed by a registered professional engineer, shall be constructed and erected in accordance with such design.

TABLE L-13—MINIMUM NOMINAL SIZE AND MAXIMUM SPACING OF MEMBERS OF OUTRIGGER SCAFFOLDS

| Maximum scaffold load | Light duty | Medium duty |
|---|---|---|
| | 25 p.s.f. | 50 p.s.f. |
| Outrigger size | 2×10 in | 3×10 in. |
| Maximum outrigger spacing. | 10 ft. 0 in | 6 ft. 0 in. |
| Planking | 2×10 in | 2×10 in. |
| Guardrail | 2×4 in | 2×4 in. |
| Guardrail uprights | 2×4 in | 2×4 in. |
| Toeboards | 4 in. (minimum). | 4 in. (minimum). |

(4) Planking shall be laid tight and shall extend to within 3 inches of the building wall. Planking shall be secured to the beams.

(5) Guardrails made of lumber, not less than 2×4 inches (or other material providing equivalent protection), approximately 42 inches high, with a midrail of 1×6 inch lumber (or other material providing equivalent protection), and toeboards, shall be installed at all open sides and ends on all scaffolds more than 10 feet above the ground or floor. Toeboards shall be a minimum of 4 inches in height. Wire mesh shall be installed in accordance with paragraph (a)(6) of this section.

(h) *Masons' adjustable multiple-point suspension scaffolds.* (1) The scaffold shall be capable of sustaining a working load of 50 pounds per square foot and shall not be loaded in excess of that figure.

(2) The scaffold shall be provided with hoisting machines that meet the requirements of Underwriters' Laboratories or Factory Mutual Engineering Corporation.

(3) The platform shall be supported by wire ropes, capable of supporting at least 6 times the intended load, suspended from overhead outrigger beams.

(4) The scaffold outrigger beams shall consist of structural metal securely fastened or anchored to the frame or floor system of the building or structure.

(5) Each outrigger beam shall be equivalent in strength to at least a standard 7-inch, 15.3-pound steel I-beam, at least 15 feet long, and shall not project more than 6 feet 6 inches beyond the bearing point.

(6) Where the overhang exceeds 6 feet 6 inches, outrigger beams shall be composed of stronger beams or multiple beams and be installed under the supervision of a competent person.

(7) All outrigger beams shall be set and maintained with their webs in a vertical position.

(8) A stop bolt shall be placed at each end of every outrigger beam.

(9) The outrigger beam shall rest on suitable wood bearing blocks.

(10) The free end of the suspension wire ropes shall be equipped with proper size thimbles and secured by splicing or other equivalent means. The running ends shall be securely attached to the hoisting drum and at least four turns of wire rope shall at all times remain on the drum. The use of fiber rope is prohibited.

(11) Where a single outrigger beam is used, the steel shackles or clevises with which the wire ropes are attached to the outrigger beams shall be placed directly over the hoisting drums.

(12) The scaffold platform shall be equivalent in strength to at least 2-inch planking. (For maximum planking spans, see paragraph (a)(11) of this section.)

(13) When employees are at work on the scaffold and an overhead hazard exists, overhead protection shall be provided on the scaffold, not more than 9 feet above the platform, consisting of 2-inch planking, or material of equivalent strength, laid tight, and extending not less than the width of the scaffold.

(14) Each scaffold shall be installed or relocated under the supervision of a competent person.

(15) Guardrails made of lumber, not less than 2×4 inches (or other material providing equivalent protection), approximately 42 inches high, with a midrail, and toeboards, shall be installed at all open sides and ends on all scaffolds more than 10 feet above the ground or floor. Toeboards shall be a minimum of 4 inches in height. Wire mesh shall be installed in accordance with paragraph (a)(6) of this section.

(i) *(Swinging scaffolds) two-point suspension.* (1) Two-point suspension scaffold platforms shall be not less than 20 inches nor more than 36 inches wide overall. The platform shall be securely fastened to the hangers by U-bolts or by other equivalent means.

(2) The hangers of two-point suspension scaffolds shall be made of mild steel, or other equivalent materials, having a cross-sectional area capable of sustaining 4 times the maximum rated load, and shall be designed with a support for guardrail, intermediate rail, and toeboard.

(3) When hoisting machines are used on two-point suspension scaffolds, such machines shall be of a design tested and approved by Underwriters' Laboratories or Factory Mutual Engineering Corporation.

(4) The roof irons or hooks shall be of mild steel, or other equivalent material, of proper size and design, securely installed and anchored. Tiebacks of ¾-inch manila rope, or the equivalent, shall serve as a secondary means of anchorage, installed at right angles to the face of the building, whenever possible, and secured to a structurally sound portion of the building.

(5) Two-point suspension scaffolds shall be suspended by wire, synthetic, or fiber ropes capable of supporting at least 6 times the rated load. All other components shall be capable of supporting at least four times the rated load.

(6) The sheaves of all blocks, consisting of at least one double and one single block, shall fit the size and type of rope used.

(7) All wire ropes, fiber and synthetic ropes, slings, hangers, platforms, and other supporting parts shall be inspected before every installation. Periodic inspections shall be made while the scaffold is in use.

(8) On suspension scaffolds designed for a working load of 500 pounds, no more than two men shall be permitted to work at one time. On suspension scaffolds with a working load of 750 pounds, no more than three men shall be permitted to work at one time. Each employee shall be protected by an approved safety life belt attached to a lifeline. The lifeline shall be securely attached to substantial members of the structure (not scaffold), or to securely rigged lines, which will safely suspend the employee in case of a fall. In order to keep the lifeline continuously attached, with a minimum of slack, to a fixed structure, the attachment point of the lifeline shall be appropriately changed as the work progresses.

(9) Two-point suspension scaffolds shall be securely lashed to the building or structure to prevent them from swaying. Window cleaners' anchors shall not be used for this purpose.

(10) The platform of every two-point suspension scaffold shall be one of the following types:

(i) *Ladder-type platforms.* The side stringer shall be of clear straight-grained spruce or materials of equivalent strength and durability. The rungs shall be of straight-grained oak, ash, or hickory, at least 1⅛ inch in diameter, with ⅞-inch tenons mortised into the side stringers at least seven-eighths inch. The stringers shall be tied together with tie rods not less than one-quarter inch in diameter, passing through the stringers and riveted up tight against washers on both ends. The flooring strips shall be spaced not more than five-eighths inch apart except at the side rails where the space may be 1 inch. Ladder-type platforms shall be constructed in accordance with Table L-14.

TABLE L-14—SCHEDULE FOR LADDER-TYPE PLATFORMS

| | Length of platform (feet) | | | | |
|---|---|---|---|---|---|
| | 12 | 14 and 16 | 18 and 20 | 22 and 24 | 28 and 30 |
| Side Stringers, minimum cross section (finished sizes): | | | | | |
| At ends (inches) | 1¾ x 2¾ | 1¾ x 2¾ | 1¾ x 3 | 1¾ x 3 | 1¾ x 3½. |
| At middle (inches) | 1¾ x 3¾ | 1¾ x 3¾ | 1¾ x 4 | 1¾x 4¼ | 1¾ x 5. |
| Reinforcing strip (minimum) | A ⅛ x ⅞-inch steel reinforcing strip or its equivalent shall be attached to the side or underside, full length. | | | | |
| Rungs | Rungs shall be 1⅛-inches minimum diameter with at least ⅞-inch diameter tenons, and the maximum spacing shall be 12 inches center to center. | | | | |
| Tie rods: | | | | | |
| Number (minimum) | 3 | 4 | 4 | 5 | 6. |
| Diameter (minimum | ¼ in | ¼ in | ¼ in | ¼ in | ¼ in. |
| Flooring, minimum finished size (inches) | ½ x 2¾ | ½ x 2¾ | ½ x 2¾ | ½ x 2¾ | ½ x 2¾. |

(ii) *Plank-type platforms.* Plank-type platforms shall be composed of not less than nominal 2- x 10-inch unspliced planks, properly cleated together on the underside, starting 6 inches from each end; intervals in between shall not exceed 4 feet. The plank-type platform shall not extend beyond the hangers more than 12 inches. A bar or other effective means shall be securely fastened to the platform at each end to prevent its slipping off the hanger. The span between hangers for plank-type platforms shall not exceed 8 feet.

(iii) *Beam-type platforms.* Beam platforms shall have side stringers of lumber not less than 2 x 6 inches set on edge. The span between hangers shall not exceed 12 feet when beam platforms are used. The flooring shall be supported on 2- x 6-inch cross beams, laid flat and set into the upper edge of the stringers with a snug fit, at intervals of not more than 4 feet, securely nailed in place. The flooring shall be of 1- x 6-inch material properly nailed. Floor boards shall not be spaced more than one-half inch apart.

(iv) *Light metal-type platforms,* when used, shall be tested and listed according to Underwriters' Laboratories or Factory Mutual Engineering Corporation.

(11) Guardrails made of lumber, not less than 2 x 4 inches (or other material providing equivalent protection), approximately 42 inches high, with a midrail, and toeboards, shall be installed at all open sides and ends on all scaffolds more than 10 feet above the ground or floor. Toeboards shall be a minimum of 4 inches in height. Wire mesh shall be installed in accordance with paragraph (a)(6) of this section.

(j) *Stone setters' adjustable multiple-point suspension scaffolds.* (1) The scaffold shall be capable of sustaining a working load of 25 pounds per square foot and shall not be overloaded. Scaffolds shall not be used for storage of stone or other heavy materials.

(2) When used, the hoisting machine and its supports shall be of a type tested and listed by Underwriters' Laboratories or Factory Mutual Engineering Corporation.

(3) The platform shall be securely fastened to the hangers by U-bolts or other equivalent means. (For materials and spans, see subdivision (ii) of paragraph (i)(10), Plank-Type Platforms, and Table L-14 of this section.)

(4) The scaffold unit shall be suspended from metal outriggers, iron brackets, wire rope slings, or iron hooks.

(5) Outriggers, when used, shall be set with their webs in a vertical position, securely anchored to the building or structure and provided with stop bolts at each end.

(6) The scaffold shall be supported by wire rope capable of supporting at least 6 times the rated load. All other components shall be capable of supporting at least 4 times the rated load.

(7) The free ends of the suspension wire ropes shall be equipped with proper size thimbles, secured by splicing or other equivalent means. The running ends shall be securely attached to the hoisting drum and at least four turns of wire rope shall remain at the drum at all times.

(8) When two or more scaffolds are used on a building or structure, they shall not be bridged one to the other, but shall be maintained at even height with platforms abutting closely.

(9) Guardrails made of lumber, not less than 2 x 4 inches (or other material providing equivalent protection), approximately 42 inches high, with a midrail, and toeboards, shall be installed at all open sides and ends on all scaffolds more than 10 feet above the ground or floor. Toeboards shall be a minimum of 4 inches in height. Wire mesh shall be installed in accordance with paragraph (a)(6) of this section.

(k) *Single-point adjustable suspension scaffolds.* (1) The scaffolding, including power units or manually operated winches, shall be of a type tested and listed by Underwriters' Laboratories or Factory Mutual Engineering Corporation.

(2) The power units may be either electrically or air motor driven.

(3) All power-operated gears and brakes shall be enclosed.

(4) In addition to the normal operating brake, all power-driven units shall have an emergency brake which engages automatically when the normal speed of descent is exceeded.

(5) The hoisting machines, cables, and equipment shall be regularly serviced and inspected.

(6) The units may be combined to form a two-point suspension scaffold. Such scaffold shall then comply with paragraph (i) of this section.

(7) The supporting cable shall be vertical for its entire length, and the basket shall not be swayed nor the cable fixed to any intermediate points to change the original path of travel.

(8) Suspension methods shall conform to applicable provisions of paragraphs (h) and (i) of this section.

(9) Guards, midrails, and toeboards shall completely enclose the cage or basket. Guardrails shall be no less than 2 x 4 inches or the equivalent, approximately 42 inches above the platform. Midrails shall be 1 x 6 inches or the equivalent, installed equidistant between the guardrail and the platform. Toeboards shall be a minimum of 4 inches in height.

(10) For additional details not covered in this paragraph, applicable technical portions of American National Standards Institute, A120.1-1970, Power-Operated Devices for Exterior Building Maintenance Powered Platforms, shall be used.

(l) *Boatswain's chairs.* (1) The chair seat shall not be less than 12 x 24 inches, and 1-inch thickness. The seat shall be reinforced on the underside by cleats securely fastened to prevent the board from splitting.

(2) The two fiber rope seat slings shall be of ⅝-inch diameter, reeved through the four seat holes so as to cross each other on the underside of the seat.

(3) Seat slings shall be of at least ⅝-inch wire rope when an employee is conducting a heat-producing process, such as gas or arc welding.

(4) The employee shall be protected by a safety belt and lifeline in accordance with § 1926.104. The attachment point of the lifeline to the structure shall be appropriately changed as the work progresses.

(5) The tackle shall consist of correct size ball bearing or bushed blocks and properly spliced ⅝-inch diameter first-grade manila rope, or equivalent.

(6) The roof irons, hooks, or the object to which the tackle is anchored, shall be securely installed. Tiebacks, when used, shall be installed at right angles to the face of the building and securely fastened.

(m) *Carpenters' bracket scaffolds.* (1) The brackets shall consist of a triangular wood frame not less than 2 x 3 inches in cross section, or of metal of equivalent strength. Each member shall be properly fitted and securely joined.

(2) Each bracket shall be attached to the structure by means of one of the following:

(i) A bolt, no less than five-eighths inch in diameter, which shall extend through to the inside of the building wall;

(ii) A metal stud attachment device;

(iii) Welding to steel tanks;

(iv) Hooking over a well-secured and adequately strong supporting member.

(3) The brackets shall be spaced no more than 8 feet apart.

(4) No more than two employees shall occupy any given 8 feet of a bracket scaffold at any one time. Tools and materials shall not exceed 75 pounds in addition to the occupancy.

(5) The platform shall consist of not less than two 2- x 10-inch nominal size planks extending not more than 12 inches or less than 6 inches beyond each end support.

(6) Guardrails made of lumber, not less than 2 x 4 inches (or other material providing equivalent protection), approximately 42 inches high, with a midrail, of 1 x 6 inch lumber (or other material providing equivalent protection), and toeboards, shall be installed at all open sides and ends on all scaffolds more than 10 feet above the ground or floor. Toeboards shall be a minimum of 4 inches in height. Wire mesh shall be installed in accordance with paragraph (a)(6) of this section.

(n) *Bricklayers' square scaffolds.* (1) The squares shall not exceed 5 feet in width and 5 feet in height.

(2) Members shall be not less than those specified in Table L–15.

TABLE L–15—MINIMUM DIMENSIONS FOR BRICKLAYERS' SQUARE SCAFFOLD MEMBERS

| *Members* | *Dimensions* |
|---|---|
| Bearers or horizontal members | 2 x 6 in. |
| Legs | 2 x 6 in. |
| Braces at corners | 1 x 6 in. |
| Braces diagonally from center frame. | 1 x 8 in. |

(3) The squares shall be reinforced on both sides of each corner with 1- x 6-inch gusset pieces. They shall also have diagonal braces 1 x 8 inches on both sides running from center to center of each member, or other means to secure equivalent strength and rigidity.

(4) The squares shall be set not more than 5 feet apart for medium duty scaffolds, and not more than 8 feet apart for light duty scaffolds. Bracing, 1 x 8 inches, extending from the bottom of each square to the top of the next square, shall be provided on both front and rear sides of the scaffold.

(5) Platform planks shall be at least 2- x 10-inch nominal size. The ends of the planks shall overlap the bearers of the squares and each plank shall be supported by not less than three squares.

(6) Bricklayers' square scaffolds shall not exceed three tiers in height and shall be so constructed and arranged that one square shall rest directly above the other. The upper tiers shall stand on a continuous row of planks laid across the next lower tier and be nailed down or otherwise secured to prevent displacement.

(7) Scaffolds shall be level and set upon a firm foundation.

(o) *Horse scaffolds.* (1) Horse scaffolds shall not be constructed or arranged more than two tiers or 10 feet in height.

(2) The members of the horses shall be not less than those specified in Table L–16.

TABLE L–16—MINIMUM DIMENSIONS FOR HORSE SCAFFOLD MEMBERS

| *Members* | *Dimensions* |
|---|---|
| Horizontal members or bearers | 3 x 4 in. |
| Legs | 1¼ x 4½ in. |
| Longitudinal brace between legs | 1 x 6 in. |
| Gusset brace at top of legs | 1 x 8 in. |
| Half diagonal braces | 1¼ x 4½ in. |

(3) Horses shall be spaced not more than 5 feet for medium duty and not more than 8 feet for light duty.

(4) When arranged in tiers, each horse shall be placed directly over the horse in the tier below.

(5) On all scaffolds arranged in tiers, the legs shall be nailed down or otherwise secured to the planks to prevent displacement or thrust and each tier shall be substantially cross braced.

(6) Horses or parts which have become weak or defective shall not be used.

(7) Guardrails made of lumber, not less than 2 x 4 inches (or other material providing equivalent protection), approximately 42 inches high, with a midrail, of 1 x 6 inch lumber (or other material providing equivalent protection), and toeboards, shall be installed at all open sides and ends on all scaffolds more than 10 feet above the ground or floor. Toeboards shall be a minimum of 4 inches in height. Wire mesh shall be installed in accordance with paragraph (a)(6) of this section.

(p) *Needle beam scaffold.* (1) Wood needle beams shall be not less than 4 x 6 inches in size, with the greater dimension placed in a vertical direction. Metal beams or the equivalent, conforming to paragraphs (a)(8) and (10) of this section, may be used and shall not be altered or moved horizontally while they are in use.

(2) Ropes or hangers shall be provided for supports. The span between supports on the needle beam shall not exceed 10 feet for 4-x 6-inch timbers. Rope supports shall be equivalent in strength to 1-inch diameter first-grade manila rope.

(3) The ropes shall be attached to the needle beams by a scaffold hitch or a properly made eye splice. The loose end of the rope shall be tied by a bowline knot or by a round turn and a half hitch.

(4) The scaffold hitch shall be arranged so as to prevent the needle beam from rolling or becoming otherwise displaced.

(5) The platform span between the needle beams shall not exceed 8 feet when using 2-inch scaffold plank. For

spans greater than 8 feet, platforms shall be designed based on design requirements for the special span. The overhang of each end of the platform planks shall be not less than 6 inches and not more than 12 inches.

(6) When needle beam scaffolds are used, the planks shall be secured against slipping.

(7) All unattached tools, bolts, and nuts used on needle beam scaffolds shall be kept in suitable containers, properly secured.

(8) One end of a needle beam scaffold may be supported by a permanent structural member conforming to paragraphs (a)(8) and (10) of this section.

(9) Each employee working on a needle beam scaffold shall be protected by a safety belt and lifeline in accordance with § 1926.104.

(q) *Plasterers', decorators', and large area scaffolds.* (1) Plasterers', lathers', and ceiling workers' inside scaffolds shall be constructed in accordance with the general requirements set forth for independent wood pole scaffolds. (See paragraph (b) and Tables L–7, 8, and 9 of this section.)

(2) All platform planks shall be laid with the edges close together.

(3) When independent pole scaffold platforms are erected in sections, such sections shall be provided with connecting runways equipped with substantial guardrails.

(4) Guardrails made of lumber, not less than 2 x 4 inches (or other material providing equivalent protection), approximately 42 inches high, with a midrail of 1 x 6 inch lumber (or other material providing equivalent protection), and toeboards, shall be installed on all open sides and ends of all scaffolds more than 10 feet above the ground or floor. Toeboards shall be a minimum of 4 inches in height. Wire mesh shall be installed in accordance with paragraph (a)(6) of this section.

(r) *Interior hung scaffolds.* (1) An interior hung scaffold shall be hung or suspended from the roof structure or ceiling beams.

(2) The suspending wire or fiber rope shall be capable of supporting at least 6 times the rated load. The rope shall be wrapped at least twice around the supporting members and twice around the bearers of the scaffold, with each end of the wire rope secured by at least three standard wire-rope clips properly installed.

(3) For hanging wood scaffolds, the following minimum nominal size material shall be used:

(i) Supporting bearers 2 x 10 inches on edge;

(ii) Planking 2 x 10 inches, with maximum span 7 feet for heavy duty and 10 feet for light duty or medium duty.

(4) Steel tube and coupler members may be used for hanging scaffolds with both types of scaffold designed to sustain a uniform distributed working load up to heavy duty scaffold loads with a safety factor of four.

(5) Guardrails made of lumber, not less than 2 x 4 inches (or other material providing equivalent protection), approximately 42 inches high, with a midrail of 1 x 6 inch lumber (or other material providing equivalent protection), and toeboards, shall be installed at all open sides and ends on all scaffolds more than 10 feet above the ground or floor. Toeboards shall be a minimum of 4 inches in height. Wire mesh shall be installed in accordance with paragraph (a)(6) of this section.

(s) *Ladder jack scaffolds.* (1) All ladder jack scaffolds shall be limited to light duty and shall not exceed a height of 20 feet above the floor or ground.

(2) All ladders used in connection with ladder jack scaffolds shall be heavy-duty ladders and shall be designed and constructed in accordance with American National Standards Institute A 14.1–1968, Safety Code for Portable Wood Ladders, and A 14.2–1968, Safety Code for Portable Metal Ladders. Cleated ladders shall not be used for this purpose.

(3) The ladder jack shall be so designed and constructed that it will bear on the side rails in addition to the ladder rungs, or if bearing on rungs only, the bearing area shall be at least 10 inches on each rung.

(4) Ladders used in conjunction with ladder jacks shall be so placed, fastened, held, or equipped with devices so as to prevent slipping.

(5) The wood platform planks shall be not less than 2 inches nominal in thickness. Both metal and wood platform planks shall overlap the bearing surface not less than 12 inches. The span between supports for wood shall not exceed 8 feet. Platform width shall be not less than 18 inches.

(6) Not more than two employees shall occupy any given 8 feet of any ladder jack scaffold at any one time.

(t) *Window jack scaffolds.* (1) Window jack scaffolds shall be used only for the purpose of working at the window opening through which the jack is placed.

(2) Window jacks shall not be used to support planks placed between one window jack and another or for other elements of scaffolding.

(3) Window jack scaffolds shall be provided with guardrails unless safety belts with lifelines are attached and provided for employee.

(4) Not more than one employee shall occupy a window jack scaffold at any one time.

(u) *Roofing brackets.* (1) Roofing brackets shall be constructed to fit the pitch of the roof.

(2) Brackets shall be secured in place by nailing in addition to the pointed metal projections. When it is impractical to nail brackets, rope supports shall be used. When rope supports are used, they shall consist of first-grade manila of at least ¾-inch diameter, or equivalent.

(3) A catch platform shall be installed below the working area of roofs more than 16 feet from the ground to eaves with a slope greater than 4 inches in 12 inches without a parapet. In width, the platform shall extend 2 feet beyond the protection of the eaves and shall be provided with a guardrail, midrail, and toeboard. This provision shall not apply where employees engaged in work upon such roofs are protected by a safety belt attached to a lifeline.

(v) *Crawling boards or chicken ladders.* (1) Crawling boards shall be not less than 10 inches wide and 1 inch thick, having cleats 1 × 1½ inches. The cleats shall be equal in length to the width of the board and spaced at equal intervals not to exceed 24 inches. Nails shall b be driven through and clinched on the underside. The crawling board shall extend from the ridge pole to the eaves when used in connection with roof construction, repair, or maintenance.

(2) A firmly fastened lifeline of at least ¾-inch diameter rope, or equivalent, shall be strung beside each crawling board for a handhold.

(3) Crawling boards shall be secured to the roof by means of adequate ridge hooks or other effective means.

(w) *Float or ship scaffolds.* (1) Float or ship scaffolds shall not be used to support more than three men and a few light tools, such as those needed for riveting, bolting, and welding. They shall be constructed as designed in subparagraph (s)(2) through (6) of this paragraph unless substitute designs and materials provide equivalent strength, stability, and safety.

(2) The platform shall be not less than 3 feet wide and 6 feet long, made of ¾-inch plywood, equivalent to American Plywood Association Grade B–B, Group I, Exterior, or other similar material.

(3) Under the platform, there shall be two supporting bearers made from 2- x 4-inch, or 1- x 10-inch, rough, "selected lumber," or better. They shall be free of knots or other flaws and project 6 inches beyond the platform on both sides. The ends of the platform shall extend 6 inches beyond the outer edges of the bearers. Each bearer shall be securely fastened to the platform.

(4) An edging of wood not less than ¾ x 1½ inches or equivalent shall be

placed around all sides of the platform to prevent tools from rolling off.

(5) Supporting ropes shall be 1-inch diameter manila rope or equivalent, free from deterioration, chemical damage, flaws, or other imperfections. Rope connections shall be such that the platform cannot shift or slip. If two ropes are used with each float, they shall be arranged so as to provide four ends which are to be securely fastened to an overhead support. Each of the two supporting ropes shall be hitched around one end of bearer and pass under the platforms to the other end of the bearer where it is hitched again, leaving sufficient rope at each end for the supporting ties.

(6) Each employee shall be protected by an approved safety lifebelt and lifeline, in accordance with § 1926.104.

(x) *Form scaffolds.* (1) Form scaffolds shall be constructed of wood or other suitable materials, such as steel or aluminum members of known strength characteristics. All scaffolds shall be designed and erected with a minimum safety factor of 4, computed on the basis of the maximum rated load.

(2) All scaffold planking shall be a minimum of 2- x 10-inch nominal Scaffold Grade, as recognized by approved grading rules for the species of lumber used, or equivalent material. Maximum permissible spans shall not exceed 8 feet on centers for 2- x 10-inch nominal planking. Scaffold planks shall be either nailed or bolted to the ledgers or of such length that they overlap the ledgers at least 6 inches. Unsupported projecting ends of scaffolding planks shall be limited to a maximum overhang of 12 inches.

(3) Scaffolds shall not be loaded in excess of the working load for which they were designed.

(4) Figure-four form scaffolds: (i) Figure-four scaffolds are intended for light duty and shall not be used to support loads exceeding 25 pounds per square foot unless specifically designed for heavier loading. For minimum design criteria, see Table L-17.

TABLE L-17—MINIMUM DESIGN CRITERIA FOR FIGURE-FOUR FORM SCAFFOLDS

| *Members* | *Dimensions* |
|---|---|
| Uprights | 2 x 4 in. or 2 x 6 in. |
| Outriggers ledgers (two) | 1 x 6 in. |
| Braces | 1 x 6 in. |
| Guardrails | 2 x 4 in. |
| Guardrail height | Approximately 42 in. |
| Intermediate guardrails | 1 x 6 in. |
| Toeboards | 4 in. (minimum). |
| Maximum length of ledgers | 3 ft. 6 in. (unsupported). |
| Planking | 2 x 10 in. |
| Upright spacing | 8 ft. 0 in. (on centers). |

(ii) Figure-four form scaffold frames shall be spaced not more than 8 feet on centers and constructed from sound lumber, as follows: The outrigger ledger shall consist of two pieces of 1- x 6-inch or heavier material nailed on opposite sides of the vertical form support. Ledgers shall project not more than 3 feet 6 inches from the outside of the form support and shall be substantially braced and secured to prevent tipping or turning. The knee or angle brace shall intersect the ledger at least 3 feet from the form at an angle of approximately 45°, and the lower end shall be nailed to a vertical support. The platform shall consist of two or more 2- x 10-inch planks, which shall be of such length that they extend at least 6 inches beyond ledgers at each end unless secured to the ledgers. When planks are secured to the ledgers (nailed or bolted), a wood filler strip shall be used between the ledgers. Unsupported projecting ends of planks shall be limited to an overhang of 12 inches.

(5) Metal bracket form scaffolds: (i) Metal brackets or scaffold jacks which are an integral part of the form shall be securely bolted or welded to the form. Folding type brackets shall be either bolted or secured with a locking-type pin when extended for use.

(ii) "Clip-on" or "hook-over" brackets may be used, provided the form walers are bolted to the form or secured by snap ties or shea-bolt extending through the form and securely anchored.

(iii) Metal brackets shall be spaced not more than 8 feet on centers.

(iv) Scaffold planks shall be either bolted to the metal brackets or of such length that they overlap the brackets at each end by at least 6 inches. Unsupported projecting ends of scaffold planks shall be limited to a maximum overhang of 12 inches.

(v) Metal bracket form scaffolds shall be equipped with wood guardrails, intermediate rails, toeboards, and scaffold planks meeting the minimum dimensions shown in Table L-18. (Metal may be substituted for wood, providing it affords equivalent or greater design strength.)

(6) Wooden bracket form scaffolds: (i) Wooden bracket form scaffolds shall be an integral part of the form panel. The minimum design criteria set forth herein and in Table L-19 cover scaffolding intended for light duty and shall not be used to support loads exceeding 25 pounds per square foot, unless specifically designed for heavier loading.

(ii) Scaffold planks shall be either nailed or bolted to the ledgers or of such length that they overlap the ledgers at each end by at least 6 inches. Unsupported projecting ends of scaffold planks shall be limited to a maximum overhang of 12 inches.

TABLE L-18—MINIMUM DESIGN CRITERIA FOR METAL BRACKET FORM SCAFFOLDS

| *Members* | *Dimensions* |
|---|---|
| Uprights | 2 x 4 in. |
| Guardrails | 2 x 4 in. |
| Guardrail height | Approximately 42 in. |
| Intermediate guardrails | 1 x 6 in. |
| Toeboards | 4 in. (minimum). |
| Planking | 2 x 9 in. |

TABLE L-19—MINIMUM DESIGN CRITERIA FOR WOODEN BRACKET FORM SCAFFOLDS

| *Members* | *Dimensions* |
|---|---|
| Uprights | 2 x 4 in. or 2 x 6 in. |
| Support ledgers | 2 x 6 in. |
| Maximum scaffold width | 3 ft. 6 in. |
| Braces | 1 x 6 in. |
| Guardrails | 2 x 4 in. |
| Guardrail height | Approximately 42 in. |
| Intermediate guardrails | 1 x 6 in. |
| Toeboards | 4 in. (minimum). |
| Upright spacing | 8 ft. 0 in. (on centers). |

(iii) Guardrails and toeboards shall be installed on all open sides and ends of platforms and scaffolding over 10 feet above floor or ground. Guardrails shall be made of lumber 2 x 4 inch nominal dimension (or other material providing equivalent protection), approximately 42 inches high, supported at intervals not to exceed 8 feet. Guardrails shall be equipped with midrails constructed of 1 x 6 inch nominal lumber (or other material providing equivalent protection). Toeboards shall extend not less than 4 inches above the scaffold plank.

(y) *Pump jack scaffolds.* (1) Pump jack scaffolds shall:

(i) Not carry a working load exceeding 500 pounds; and

(ii) Be capable of supporting without failure at least four times the maximum intended load.

(iii) The manufactured components shall not be loaded in excess of the manufacturer's recommended limits.

(2) Pump jack brackets, braces, and accessories shall be fabricated from metal plates and angles. Each pump jack bracket shall have two positive gripping mechanisms to prevent any failure or slippage.

(3) The platform bracket shall be fully decked and the planking secured. Planking, or equivalent, shall conform with paragraph (a) of this section.

(4)(i) When wood scaffold planks are used as platforms, poles used for pump jacks shall not be spaced more than 10 feet center to center. When fabricated platforms are used that fully comply with all other provisions of this paragraph (y), pole spacing may exceed 10 feet center to center.

(ii) Poles shall not exceed 30 feet in height.

(iii) Poles shall be secured to the work wall by rigid triangular bracing, or equivalent, at the bottom, top, and other points as necessary, to provide a maximum vertical spacing of not more than 10 feet between braces. Each brace shall be capable of supporting a minimum of 225 pounds tension or compression.

(iv) For the pump jack bracket to pass bracing already installed, an

extra brace shall be used approximately 4 feet above the one to be passed until the original brace is reinstalled.

(5) All poles shall bear on mud sills or other adequate firm foundations.

(6) Pole lumber shall be two 2 x 4's, of Douglas fir, or equivalent, straight-grained, clear, free of cross-grain, shakes, large loose or dead knots, and other defects which might impair strength.

(7) When poles are constructed of two continuous lengths, they shall be two by fours, spiked together with the seam parallel to the bracket, and with 10d common nails, no more than 12 inches center to center, staggered uniformly from opposite outside edges.

(8) If two by fours are spliced to make up the pole, the splices shall be so constructed as to develop the full strength of the member.

(9) A ladder, in accordance with § 1926.450, shall be provided for access to the platform during use.

(10) Not more than two persons shall be permitted at one time upon a pump jack scaffold between any two supports.

(11) Pump jacks scaffolds shall be provided with standard guardrails as defined in § 1926.451(a)(15), but no guardrail is required when safety belts with lifelines are provided for employees.

(12) When a work bench is used at an approximate height of 42 inches, the top guardrail may be eliminated, if the work bench is fully decked, the planking secured, and is capable of withstanding 200 pounds pressure in any direction.

(13) Employees shall not be permitted to use a work bench as a scaffold platform.

The following requirements from 29 CFR Part 1910 (General Industry) have been identified as applicable to construction (29 CFR 1926.451 *Scaffolding*), in accordance with their respective scope and definitions.

**§ 1910.21 Definitions.**

* * * * *

(g) * * *

(9) *Ladder stand.* A mobile fixed size self-supporting ladder consisting of a wide flat tread ladder in the form of stairs. The assembly may include handrails.

* * * * *

**§ 1910.28 Safety requirements for scaffolding.**

(a) * * *

(15) Materials being hoisted onto a scaffold shall have a tag line.

* * * * *

(18) Employees shall not work on scaffolds during storms or high winds.

* * * * *

(20) Tools, materials, and debris shall not be allowed to accumulate in quantities to cause a hazard.

* * * * *

**§ 1910.29 Manually propelled mobile ladder stands and scaffolds (towers).**

(a) *General requirements.*—(1) *Application.* This section is intended to prescribe rules and requirements for the design, construction, and use of mobile work platforms (including ladder stands but not including aerial ladders) and rolling (mobile) scaffolds (towers). This standard is promulgated to aid in providing for the safety of life, limb, and property, by establishing minimum standards for structural design requirements and for the use of mobile work platforms and towers.

(2) *Working loads.* (i) Work platforms and scaffolds shall be capable of carrying the design load under varying circumstances depending upon the conditions of use. Therefore, all parts and appurtenances necessary for their safe and efficient utilization must be integral parts of the design.

(ii) Specific design and construction requirements are not a part of this section because of the wide variety of materials and design possibilities. However, the design shall be such as to produce a mobile ladder stand or scaffold that will safely sustain the specified loads. The material selected shall be of sufficient strength to meet the test requirements and shall be protected against corrosion or deterioration.

(*a*) The design working load of ladder stands shall be calculated on the basis of one or more 200-pound persons together with 50 pounds of equipment each.

(*b*) The design load of all scaffolds shall be calculated on the basis of:

*Light*—Designed and constructed to carry a working load of 25 pounds per square foot.

*Medium*—Designed and constructed to carry a working load of 50 pounds per square foot.

*Heavy*—Designed and constructed to carry a working load of 75 pounds per square foot.

All ladder stands and scaffolds shall be capable of supporting at least four times the design working load.

(iii) The materials used in mobile ladder stands and scaffolds shall be of standard manufacture and conform to standard specifications of strength, dimensions, and weights, and shall be selected to safely support the design working load.

(iv) Nails, bolts, or other fasteners used in the construction of ladders, scaffolds, and towers shall be of adequate size and in sufficient numbers at each connection to develop the designed strength of the unit. Nails shall be driven full length. (All nails should be immediately withdrawn from dismantled lumber.)

(v) All exposed surfaces shall be free from sharp edges, burrs or other safety hazards.

(3) *Work levels.* (i) The maximum work level height shall not exceed four (4) times the minimum or least base dimensions of any mobile ladder stand or scaffold. Where the basic mobile unit does not meet this requirement, suitable outrigger frames shall be employed to achieve this least base dimension, or provisions shall be made to guy or brace the unit against tipping.

(ii) The minimum platform width for any work level shall not be less than 20 inches for mobile scaffolds (towers). Ladder stands shall have a minimum step width of 16 inches.

(iii) The supporting structure for the work level shall be rigidly braced, using adequate cross bracing or diagonal bracing with rigid platforms at each work level.

(iv) The steps of ladder stands shall be fabricated from slip resistant treads.

(v) The work level platform of scaffolds (towers) shall be of wood, aluminum, or plywood planking, steel or expanded metal, for the full width of the scaffold, except for necessary openings. Work platforms shall be secured in place. All planking shall be 2-inch (nominal) scaffold grade minimum 1,500 *f.* (stress grade) construction grade lumber or equivalent.

(vi) All scaffold work levels 10 feet or higher above the ground or floor shall have a standard (4-inch nominal) toeboard.

(vii) All work levels 10 feet or higher above the ground or floor shall have a guardrail of 2- by 4-inch nominal or the equivalent installed no less than 36 inches or more than 42 inches high, with a mid-rail, when required, of 1- by 4-inch nominal lumber or equivalent.

(viii) A climbing ladder or stairway shall be provided for proper access and egress, and shall be af-

fixed or built into the scaffold and so located that its use will not have a tendency to tip the scaffold. A landing platform shall be provided at intervals not to exceed 30 feet.

(4) *Wheels or casters.* (i) Wheels or casters shall be properly designed for strength and dimensions to support four (4) times the design working load.

(ii) All scaffold casters shall be provided with a positive wheel and/or swivel lock to prevent movement. Ladder stands shall have at least two (2) of the four (4) casters and shall be of the swivel type.

(iii) Where leveling of the elevated work platform is required, screw jacks or other suitable means for adjusting the height shall be provided in the base section of each mobile unit.

* * * * *

(c) *Mobile tubular welded sectional folding scaffolds.*—(1) *General.* Units including sectional stairway and sectional ladder scaffolds shall be designed to comply with the requirements of paragraph (a) of this section.

(2) *Stairway.* An integral stairway and work platform shall be incorporated into the structure of each sectional folding stairway scaffold.

(3) *Bracing.* An integral set of pivoting and hinged folding diagonal and horizontal braces and a detachable work platform shall be incorporated into the structure of each sectional folding ladder scaffold.

(4) *Sectional folding stairway scaffolds.* Sectional folding stairway scaffolds shall be designed as medium duty scaffolds except for high clearance. These special base sections shall be designed as light duty scaffolds. When upper sectional folding stairway scaffolds are used with a special high clearance base, the load capacity of the entire scaffold shall be reduced accordingly. The width of a sectional folding stairway scaffold shall not exceed 4½ feet. The maximum length of a sectional folding stairway scaffold shall not exceed 6 feet.

(5) *Sectional folding ladder scaffolds.* Sectional folding ladder scaffolds shall be designed as light duty scaffolds including special base (open end) sections which are designed for high clearance. For certain special applications the six-foot (6′) folding ladder scaffolds, except for special high clearance base sections, shall be designed for use as medium duty scaffolds. The width of a sectional folding ladder scaffold shall not exceed 4½ feet. The maximum length of a sectional folding ladder scaffold shall not exceed 6 feet 6 inches for a six-foot (6′) long unit, 8 feet 6 inches for an eight-foot (8′) unit or 10 feet 6 inches for a ten-foot (10′) long unit.

(6) *End frames.* The end frames of sectional ladder and stairway scaffolds shall be designed so that the horizontal bearers provide supports for multiple planking levels.

(7) *Erection.* Only the manufacturer of the scaffold or his qualified designated agent shall be permitted to erect or supervise the erection of scaffolds exceeding 50 feet in height above the base, unless such structure is approved in writing by a licensed professional engineer, or erected in accordance with instructions furnished by the manufacturer.

* * * * *

**§ 1926.452 Definitions applicable to this subpart.**

(a) *"Ladders"*—(1) "Cleats"—Ladder crosspieces of rectangular cross section placed on edge on which a person may step in ascending or descending.

(2) "Single cleat ladder"—One which consists of a pair of side rails, usually parallel, but with flared side rails permissible, connected together with cleats that are joined to the side rails at regular intervals.

(3) "Double cleat ladder"—One that is similar to a single cleat ladder, but is wider, with an additional center rail which will allow for two-way traffic for workmen in ascending and descending.

(b) *"Scaffolding"*—(1) "Bearer"—A horizontal member of a scaffold upon which the platform rests and which may be supported by ledgers.

(2) "Boatswain's chair"—A seat supported by slings attached to a suspended rope, designed to accommodate one workman in a sitting position.

(3) "Brace"—A tie that holds one scaffold member in a fixed position with respect to another member.

(4) "Bricklayers' square scaffold"—A scaffold composed of framed wood squares which support a platform, limited to light and medium duty.

(5) "Carpenters' bracket scaffold"—A scaffold consisting of wood or metal brackets supporting a platform.

(6) "Coupler"—A device for locking together the component parts of a tubular metal scaffold. (The material used for the couplers shall be of a structural type, such as a drop-forged steel, malleable iron, or structural grade aluminum.)

(7) "Crawling board or chicken ladder"—A plank with cleats spaced and secured at equal intervals, for use by a worker on roofs, not designed to carry any material.

(8) "Double pole or independent pole scaffold"—A scaffold supported from the base by a double row of uprights, independent of support from the walls and constructed of uprights, ledgers, horizontal platform bearers, and diagonal bracing.

(9) "Float or ship scaffold"—A scaffold hung from overhead supports by means of ropes and consisting of a substantial platform having diagonal bracing underneath, resting upon and securely fastened to two parallel plank bearers at right angles to the span.

(10) "Guardrail"—A rail secured to uprights and erected along the exposed sides and ends of platforms.

(11) "Heavy duty scaffold"—A scaffold designed and constructed to carry a working load not to exceed 75 pounds per square foot.

(12) "Horse scaffold"—A scaffold for light or medium duty, composed of horses supporting a work platform.

(13) "Interior hung scaffold"—A scaffold suspended from the ceiling or roof structure.

(14) "Ladder jack scaffold"—A light duty scaffold supported by brackets attached to ladders.

(15) "Ledgers (stringers)"—A horizontal scaffold member which extends from post to post and which supports the putlogs or bearers forming a tie between the posts.

(16) "Light duty scaffold"—A scaffold designed and constructed to carry a working load not to exceed 25 pounds per square foot.

(17) "Manually propelled mobile scaffold"—A portable rolling scaffold supported by casters.

(18) "Masons' adjustable multiple-point suspension scaffold"—A scaffold having a continuous platform supported by bearers suspended by wire rope from overhead supports, so arranged and operated as to permit the raising or lowering of the platform to desired working positions.

(19) "Maximum rated load"—The total of all loads including the working load, the weight of the scaffold, and such other loads as may be reasonably anticipated.

(20) "Medium duty scaffold"—A scaffold designed and constructed to carry a working load not to exceed 50 pounds per square foot.

(21) "Midrail"—A rail approximately midway between the guardrail and platform, secured to the uprights erected along the exposed sides and ends of platforms.

(22) "Needle beam scaffold"—A light duty scaffold consisting of needle beams supporting a platform.

(23) "Outrigger scaffold"—A scaffold supported by outriggers or thrustouts projecting beyond the wall or face of

the building or structure, the inboard ends of which are secured inside of such building or structure.

(24) "Putlog"—A scaffold member upon which the platform rests.

(25) "Roofing or bearer bracket"—A bracket used in slope roof construction, having provisions for fastening to the roof or supported by ropes fastened over the ridge and secured to some suitable object.

(26) "Runner"—The lengthwise horizontal bracing or bearing members or both.

(27) "Scaffold"—Any temporary elevated platform and its supporting structure used for supporting workmen or materials, or both.

(28) "Single-point adjustable suspension scaffold"—A manually or power-operated unit designed for light duty use, supported by a single wire rope from an overhead support so arranged and operated as to permit the raising or lowering of platform to desired working positions.

(29) "Single-pole scaffold"—Platforms resting on putlogs or cross beams, the outside ends of which are supported on ledgers secured to a single row of posts or uprights, and the inner ends of which are supported on or in a wall.

(30) "Stone setters' adjustable multiple-point suspension scaffold"—A swinging type scaffold having a platform supported by hangers suspended at four points so as to permit the raising or lowering of the platform to the desired working position by the use of hoisting machines.

(31) "Toeboard"—A barrier secured along the sides and ends of a platform to guard against the falling of material.

(32) "Tube and coupler scaffold"—An assembly consisting of tubing which serves as posts, bearers, braces, ties, and runners, a base supporting the posts, and special couplers which serve to connect the uprights and to join the various members.

(33) "Tubular welded frame scaffold"—A sectional panel or frame metal scaffold substantially built up of prefabricated welded sections which consists of posts and horizontal bearer with intermediate members.

(34) "Two-point suspension scaffold (swinging scaffold)"—A scaffold, the platform of which is supported by hangers (stirrups) at two points, suspended from overhead supports so as to permit the raising or lowering of the platform to the desired working position by tackle or hoisting machines.

(35) "Window jack scaffold"—A scaffold, the platform of which is supported by a bracket or jack which projects through a window opening.

(36) "Working load"—Load imposed by men, materials, and equipment.

## Subpart M—Floor and Wall Openings, and Stairways [1]

Sec.

1926.500 Guardrails, handrails, and covers.
*1910.23 Guarding floor and wall openings and holes.*
*1910.21 Definitions.*
1926.501 Stairways.
1926.502 Definitions applicable to this subpart.

### § 1926.500 Guardrails, handrails, and covers.

(a) *General provision.* This subpart shall apply to temporary or emergency conditions where there is danger of employees or materials falling through floor, roof, or wall openings, or from stairways or runways.

(b) *Guarding of floor openings and floor holes.* (1) Floor openings shall be guarded by a standard railing and toeboards or cover, as specified in paragraph (f) of this section. In general, the railing shall be provided on all exposed sides, except at entrances to stairways.

(2) Ladderway floor openings or platforms shall be guarded by standard railings with standard toeboards on all exposed sides, except at entrance to opening, with the passage through the railing either provided with a swinging gate or so offset that a person cannot walk directly into the opening.

(3) Hatchways and chute floor openings shall be guarded by one of the following:

(i) Hinged covers of standard strength and construction and a standard railing with only one exposed side. When the opening is not in use, the cover shall be closed or the exposed side shall be guarded at both top and intermediate positions by removable standard railings;

(ii) A removable standard railing with toe board on not more than two sides of the opening and fixed standard railings with toeboards on all other exposed sides. The removable railing shall be kept in place when the opening is not in use and should preferably be hinged or otherwise mounted so as to be conveniently replaceable.

(4) Wherever there is danger of falling through a skylight opening, it shall be guarded by a fixed standard railing on all exposed sides or a cover capable of sustaining the weight of a 200-pound person.

(5) Pits and trap-door floor openings shall be guarded by floor opening covers of standard strength and construction. While the cover is not in place, the pit or trap openings shall be protected on all exposed sides by removable standard railings.

(6) Manhole floor openings shall be guarded by standard covers which need not be hinged in place. While the cover is not in place, the manhole opening shall be protected by standard railings.

(7) Temporary floor openings shall have standard railings.

(8) Floor holes, into which persons can accidentally walk, shall be guarded by either a standard railing with standard toeboard on all exposed sides, or a floor hole cover of standard strength and construction that is secured against accidental displacement. While the cover is not in place, the floor hole shall be protected by a standard railing.

(9) Where doors or gates open directly on a stairway, a platform shall be provided, and the swing of the door shall not reduce the effective width of the platform to less than 20 inches.

(c) *Guarding of wall openings.* (1) Wall openings, from which there is a drop of more than 4 feet, and the bottom of the opening is less than 3 feet above the working surface, shall be guarded as follows:

(i) When the height and placement of the opening in relation to the working surface is such that either a standard rail or intermediate rail will effectively reduce the danger of falling, one or both shall be provided;

(ii) The bottom of a wall opening, which is less than 4 inches above the working surface, regardless of width, shall be protected by a standard toeboard or an enclosing screen either of solid construction or as specified in paragraph (f)(7)(ii) of this section.

(2) An extension platform outside a wall opening onto which materials can be hoisted for handling shall have side rails or equivalent guards of standard specifications. One side of an extension platform may have removable railings in order to facilitate handling materials.

(3) When a chute is attached to an opening, the provisions of paragraph (c)(1) of this section shall apply, except that a toeboard is not required.

(d) *Guarding of open-sided floors, platforms, and runways.* (1) Every open-sided floor or platform 6 feet or more above adjacent floor or ground level shall be guarded by a standard railing, or the equivalent, as specified in paragraph (f)(1) of this section, on all open sides, except where there is entrance to a ramp, stairway, or fixed ladder. The railing shall be provided with a standard toeboard wherever, beneath the open sides, persons can pass, or there is moving machinery, or there is equipment with which falling materials could create a hazard.

(2) Runways shall be guarded by a standard railing, or the equivalent, as specified in paragraph (f) of this section, on all open sides, 4 feet or more

[1] Portions of the listed Part 1910 standards have been identified as applicable to construction.

above floor or ground level. Wherever tools, machine parts, or materials are likely to be used on the runway, a toeboard shall also be provided on each exposed side.

(3) Runways used exclusively for special purposes may have the railing on one side omitted where operating conditions necessitate such omission, providing the falling hazard is minimized by using a runway not less than 18 inches wide.

(4) Where employees entering upon runways become thereby exposed to machinery, electrical equipment, or other danger not a falling hazard, additional guarding shall be provided.

(5) Regardless of height, open-sided floors, walkways, platforms, or runways above or adjacent to dangerous equipment, pickling or galvanizing tanks, degreasing units, and similar hazards shall be guarded with a standard railing and toeboard.

(e) *Stairway railings and guards.* (1) Every flight of stairs having four or more risers shall be equipped with standard stair railings or standard handrails as specified below, the width of the stair to be measured clear of all obstructions except handrails:

(i) On stairways less than 44 inches wide having both sides enclosed, at least one handrail, preferably on the right side descending;

(ii) On stairways less than 44 inches wide having one side open, at least one stair railing on the open side;

(iii) On stairways less than 44 inches wide having both sides open, one stair railing on each side;

(iv) On stairways more than 44 inches wide but less than 88 inches wide, one handrail on each enclosed side and one stair railing on each open side;

(v) On stairways 88 or more inches wide, one handrail on each enclosed side, one stair railing on each open side, and one intermediate stair railing located approximately midway of the width.

(2) Winding stairs shall be equipped with a handrail offset to prevent walking on all portions of the treads having width less than 6 inches.

(f) *Standard specifications.* (1) A standard railing shall consist of top rail, intermediate rail, toeboard, and posts, and shall have a vertical height of approximately 42 inches from upper surface of top rail to floor, platform, runway, or ramp level. The top rail shall be smooth-surfaced throughout the length of the railing. The intermediate rail shall be halfway between the top rail and the floor, platform, runway, or ramp. The ends of the rails shall not overhang the terminal posts except where such overhang does not constitute a projection hazard. Minimum requirements for standard railings under various types of construction are specified in the following paragraphs:

(i) For wood railings, the posts shall be of at least 2-inch by 4-inch stock spaced not to exceed 8 feet; the toprail shall be of at least 2-inch by 4-inch stock; the intermediate rail shall be of at least 1-inch by 6-inch stock.

(ii) For pipe railings, posts and top and intermediate railings shall be at least 1½ inches nominal diameter with posts spaced not more than 8 feet on centers.

(iii) For structural steel railings, posts and top and intermediate rails shall be of 2-inch by 2-inch by ⅜-inch angles or other metal shapes of equivalent bending strength, with posts spaced not more than 8 feet on centers.

(iv) The anchoring of posts and framing of members for railings of all types shall be of such construction that the completed structure shall be capable of withstanding a load of at least 200 pounds applied in any direction at any point on the top rail, with a minimum of deflection.

(v) Railings receiving heavy stresses from employees trucking or handling materials shall be provided additional strength by the use of heavier stock, closer spacing of posts, bracing, or by other means.

(vi) Other types, sizes, and arrangements of railing construction are acceptable, provided they meet the following conditions:

(*a*) A smooth-surfaced top rail at a height above floor, platform, runway, or ramp level of approximately 42 inches;

(*b*) A strength to withstand at least the minimum requirement of 200 pounds top rail pressure with a minimum of deflection;

(*c*) Protection between top rail and floor, platform, runway, ramp, or stair treads, equivalent at least to that afforded by a standard intermediate rail;

(*d*) Elimination of overhang of rail ends unless such overhang does not constitute a hazard.

(2) A stair railing shall be of construction similar to a standard railing, but the vertical height shall be not more than 34 inches nor less than 30 inches from upper surface of top rail to surface of tread in line with face of riser at forward edge of tread.

(3) (i) A standard toeboard shall be 4 inches minimum in vertical height from its top edge to the level of the floor, platform, runway, or ramp. It shall be securely fastened in place and have not more than ¼-inch clearance above floor level. It may be made of any substantial material, either solid, or with openings not over 1 inch in greatest dimension.

(ii) Where material is piled to such height that a standard toeboard does not provide protection, paneling or screening from floor to intermediate rail or to top rail shall be provided.

(4) (i) A standard handrail shall be of construction similar to a standard railing except that it is mounted on a wall or partition, and does not include an intermediate rail. It shall have a smooth surface along the top and both sides of the handrail. The handrail shall have an adequate handhold for any one grasping it to avoid falling. Ends of the handrail shall be constructed so as not to constitute a projection hazard.

(ii) The height of handrails shall be not more than 34 inches nor less than 30 inches from upper surface of handrail to surface of tread, in line with face of riser or to surface of ramp.

(iii) All handrails and railings shall be provided with a clearance of approximately 3 inches between the handrail or railing and any other object.

(5) Floor opening covers shall be of any material that meets the following strength requirements:

(i) Conduits, trenches, and manhole covers and their supports, when located in roadways, and vehicular aisles, shall be designed to carry a truck rear-axle load of at least 2 times the maximum intended load;

(ii) The floor opening cover shall be capable of supporting the maximum intended load and so installed as to prevent accidental displacement.

(6) Skylight openings that create a falling hazard shall be guarded with a standard railing, or covered in accordance with paragraph (5)(ii) of this paragraph.

(7) Wall opening protection shall meet the following requirements:

(i) Barriers shall be of such construction and mounting that, when in place at the opening, the barrier is capable of withstanding a load of at least 200 pounds applied in any direction (except upward), with a minimum of deflection at any point on the top rail or corresponding member.

(ii) Screens shall be of such construction and mounting that they are capable of withstanding a load of at least 200 pounds applied horizontally at any point on the near side of the screen. They may be of solid construction, of grill work with openings not more than 8 inches long, or of slat work with openings not more than 4 inches wide with length unrestricted.

The following requirement from 29 CFR Part 1910 (General Industry) has been identified as applicable to construction (29 CFR 1926.500 *Guardrails, Handrails, and Covers*), *in accordance with the definition noted below.;*

**§ 1910.23 Guarding floor and wall openings and holes.**

* * * * *

(b) * * *

(5) Where there is a hazard of materials falling through a wall hole, and the lower edge of the near side of the hole is than 4 inches above the floor, and the far side of the hole more than 5 feet above the next lower level, the hole shall be protected by a standard toeboard, or an enclosing screen either of solid construction, or as specified in paragraph (e)(11) of this section.

* * * * *

**§ 1910.21 Definitions.**

(a) * * *

(10) *Wall hole.* An opening less than 30 inches but more than 1 inch high, of unrestricted width, in any wall or partition; such as a ventilation hole or drainage scupper.

* * * * *

---

**§ 1926.501 Stairways.**

(a) On all structures, two or more floors (20 feet or over) in height, stairways, ladders, or ramps shall be provided for employees during the construction period.

(b) Stairway railings and guardrails shall meet the requirements of § 1926.500 (e) and (f).

(c) All parts of stairways shall be free of hazardous projections, such as protruding nails.

(d) Debris, and other loose materials, shall not be allowed on or under stairways.

(e) Slippery conditions on stairways shall be eliminated as soon as possible after they occur.

(f) Permanent steel or other metal stairways, and landings with hollow pan-type treads that are to be filled with concrete or other materials, when used during construction, shall be filled to the level of the nosing with solid material. The requirement shall not apply during the period of actual construction of the stairways themselves.

(g) Wooden treads for temporary service shall be full width.

(h) Metal landings shall be secured in place before filling.

(i) Temporary stairs shall have a landing not less than 30 inches in the direction of travel at every 12 feet of vertical rise.

(j) Stairs shall be installed at angles to the horizontal of between 30° and 50°.

(k) Rise height and tread width shall be uniform throughout any flight of stairs including any foundation structure used as one or more treads of the stairs.

(l) All stairs shall be lighted in accordance with Subpart D of this part.

(m) Spiral stairways shall not be permitted except for special limited usage and secondary access situations where it is not practical to provide a conventional stairway.

**§ 1926.502 Definitions applicable to this subpart.**

(a) "Floor hole"—An opening measuring less than 12 inches but more than 1 inch in its least dimension in any floor, roof, or platform through which materials but not persons may fall, such as a belt hold, pipe opening, or slot opening.

(b) "Floor opening"—An opening measuring 12 inches or more in its least dimension in any floor, roof, or platform through which persons may fall.

(c) "Handrail"—A bar or pipe supported on brackets from a wall or partition, as on a stairway or ramp, to furnish persons with a handhold in case of tripping.

(d) "Nose, nosing"—That portion of a tread projecting beyond the face of the riser immediately below.

(e) "Platform"—A working space for persons, elevated above the surrounding floor or ground, such as a balcony or platform for the operation of machinery and equipment.

(f) "Runway"—A passageway for persons, elevated above the surrounding floor or ground level, such as a footwalk along shafting or a walkway between buildings.

(g) "Rise"—The vertical distance from the top of a tread to the top of the next higher tread.

(h) "Stair platform"—An extended step or landing breaking a continuous run of stairs.

(i) "Stair railing"—A vertical barrier erected along exposed sides of a stairway to prevent falls of persons.

(j) "Stairs, stairways"—A series of steps leading from one level or floor to another, or leading to platforms, pits, boiler rooms, crossovers, or around machinery, tanks, and other equipment that are used more or less continuously or routinely by employees or only occasionally by specific individuals. For the purpose of this subpart, a series of steps and landings having three or more rises constitutes stairs or stairway.

(k) "Standard railing"—A vertical barrier erected along exposed edges of a floor opening, wall opening, ramp, platform, or runway to prevent falls of persons.

(l) "Standard strength and construction"—Any construction of railings, covers, or other guards that meets the requirements of this subpart.

(m) "Toeboard"—A vertical barrier at floor level erected along exposed edges of a floor opening, wall opening, platform, runway, or ramp to prevent falls of materials.

(n) "Tread width"—The horizontal distance from front to back of tread, including nosing, when used.

(o) "Wall opening"—An opening at least 30 inches high and 18 inches wide, in any wall or partition, through which persons may fall, such as a yard-arm doorway or chute opening.

## Subpart N—Cranes, Derricks, Hoists, Elevators, and Conveyors

Sec.
1926.550 Cranes and derricks.
1926.551 Helicopters.
1926.552 Material hoists and personel hoists and elevators.
1926.553 Base-mounted drum hoists.
1926.554 Overhead hoists.
1926.555 Conveyors.
1926.556 Aerial lifts.

**§ 1926.550 Cranes and derricks.**

(a) *General requirements.* (1) The employer shall comply with the manufacturer's specifications and limitations applicable to the operation of any and all cranes and derricks. Where manufacturer's specifications are not available, the limitations assigned to the equipment shall be based on the determinations of a qualified engineer competent in this field and such determinations will be appropriately documented and recorded. Attachments used with cranes shall not exceed the capacity, rating, or scope recommended by the manufacturer.

(2) Rated load capacities, and recommended operating speeds, special hazard warnings, or instruction, shall be conspicuously posted on all equipment. Instructions or warnings shall be visible to the operator while he is at his control station.

(3) [Revoked]

(4) Hand signals to crane and derrick operators shall be those prescribed by the applicable ANSI standard for the type of crane in use. An illustration of the signals shall be posted at the job site.

(5) The employer shall designate a competent person who shall inspect all machinery and equipment prior to each use, and during use, to make sure it is in safe operating condition. Any deficiencies shall be repaired, or defective parts replaced, before continued use.

(6) A thorough, annual inspection of the hoisting machinery shall be made by a competent person, or by a government or private agency recognized by the U.S. Department of Labor. The employer shall maintain a record of the dates and results of inspections for each hoisting machine and piece of equipment.

(7) Wire rope shall be taken out of service when any of the following conditions exist:

(i) In running ropes, six randomly distributed broken wires in one lay or

three broken wires in one strand in one lay;

(ii) Wear of one-third the original diameter of outside individual wires. Kinking, crushing, bird caging, or any other damage resulting in distortion of the rope structure;

(iii) Evidence of any heat damage from any cause;

(iv) Reductions from nominal diameter of more than one-sixty-fourth inch for diameters up to and including five-sixteenths inch, one-thirty-second inch for diameters three-eighths inch to and including one-half inch, three-sixty-fourths inch for diameters nine-sixteenths inch to and including three-fourths inch, one-sixteenth inch for diameters seven-eighths inch to 1⅛ inches inclusive, three-thirty-seconds inch for diameters 1¼ to 1½ inches inclusive;

(v) In standing ropes, more than two broken wires in one lay in sections beyond end connections or more than one broken wire at an end connection.

(vi) Wire rope safety factors shall be in accordance with American National Standards Institute B30.5-1968 or SAE J959-1966.

(8) Belts, gears, shafts, pulleys, sprockets, spindles, drums, fly wheels, chains, or other reciprocating, rotating, or other moving parts or equipment shall be guarded if such parts are exposed to contact by employees, or otherwise create a hazard. Guarding shall meet the requirements of the American National Standards Institute B15.1-1958 Rev., Safety Code for Mechanical Power Transmission Apparatus.

(9) Accessible areas within the swing radius of the rear of the rotating superstructure of the crane, either permanently or temporarily mounted, shall be barricaded in such a manner as to prevent an employee from being struck or crushed by the crane.

(10) All exhaust pipes shall be guarded or insulated in areas where contact by employees is possible in the performance of normal duties.

(11) Whenever internal combustion engine powered equipment exhausts in enclosed spaces, tests shall be made and recorded to see that employees are not exposed to unsafe concentrations of toxic gases or oxygen deficient atmospheres.

(12) All windows in cabs shall be of safety glass, or equivalent, that introduces no visible distortion that will interfere with the safe operation of the machine.

(13) (i) Where necessary for rigging or service requirements, a ladder, or steps, shall be provided to give access to a cab roof.

(ii) Guardrails, handholds, and steps shall be provided on cranes for easy access to the car and cab, conforming to American National Standards Institute B30.5.

(iii) Platforms and walkways shall have anti-skid surfaces.

(14) Fuel tank filler pipe shall be located in such a position, or protected in such manner, as to not allow spill or overflow to run onto the engine, exhaust, or electrical equipment of any machine being fueled.

(i) An accessible fire extinguisher of 5BC rating, or higher, shall be available at all operator stations or cabs of equipment.

(ii) All fuels shall be transported, stored, and handled to meet the rules of Subpart F of this part. When fuel is transported by vehicles on public highways, Department of Transportation rules contained in 49 CFR Parts 177 and 393 concerning such vehicular transportation are considered applicable.

(15) Except where electrical distribution and transmission lines have been deenergized and visibly grounded at point of work or where insulating barriers, not a part of or an attachment to the equipment or machinery, have been erected to prevent physical contact with the lines, equipment or machines shall be operated proximate to power lines only in accordance with the following:

(i) For lines rated 50 kV. or below, minimum clearance between the lines and any part of the crane or load shall be 10 feet;

(ii) For lines rated over 50 kV., minimum clearance between the lines and any part of the crane or load shall be 10 feet plus 0.4 inch for each 1 kV. over 50 kV., or twice the length of the line insulator, but never less than 10 feet;

(iii) In transit with no load and boom lowered, the equipment clearance shall be a minimum of 4 feet for voltages less than 50 kV., and 10 feet for voltages over 50 kV., up to and including 345 kV., and 16 feet for voltages up to and including 750 kV.

(iv) A person shall be designated to observe clearance of the equipment and give timely warning for all operations where it is difficult for the operator to maintain the desired clearance by visual means;

(v) Cage-type boom guards, insulating links, or proximity warning devices may be used on cranes, but the use of such devices shall not alter the requirements of any other regulation of this part even if such device is required by law or regulation;

(vi) Any overhead wire shall be considered to be an energized line unless and until the person owning such line or the electrical utility authorities indicate that it is not an energized line and it has been visibly grounded;

(vii) Prior to work near transmitter towers where an electrical charge can be induced in the equipment or materials being handled, the transmitter shall be de-energized or tests shall be made to determine if electrical charge is induced on the crane. The following precautions shall be taken when necessary to dissipate induced voltages:

(*a*) The equipment shall be provided with an electrical ground directly to the upper rotating structure supporting the boom; and

(*b*) Ground jumper cables shall be attached to materials being handled by boom equipment when electrical charge is induced while working near energized transmitters. Crews shall be provided with nonconductive poles having large alligator clips or other similar protection to attach the ground cable to the load.

(*c*) Combustible and flammable materials shall be removed from the immediate area prior to operations.

(16) No modifications or additions which affect the capacity or safe operation of the equipment shall be made by the employer without the manufacturer's written approval. If such modifications or changes are made, the capacity, operation, and maintenance instruction plates, tags, or decals, shall be changed accordingly. In no case shall the original safety factor of the equipment be reduced.

(17) The employer shall comply with Power Crane and Shovel Association Mobile Hydraulic Crane Standard No. 2.

(18) Sideboom cranes mounted on wheel or crawler tractors shall meet the requirements of SAE J743a-1964.

(b) *Crawler, locomotive, and truck cranes.* (1) All jibs shall have positive stops to prevent their movement of more than 5° above the straight line of the jib and boom on conventional type crane booms. The use of cable type belly slings does not constitute compliance with this rule.

(2) All crawler, truck, or locomotive cranes in use shall meet the applicable requirements for design, inspection, construction, testing, maintenance and operation as prescribed in the ANSI B30.5-1968, Safety Code for Crawler, Locomotive and Truck Cranes.

(c) *Hammerhead tower cranes.* (1) Adequate clearance shall be maintained between moving and rotating structures of the crane and fixed objects to allow the passage of employees without harm.

(2) Employees required to perform duties on the horizontal boom of hammerhead tower cranes shall be protected against falling by guardrails or by safety belts and lanyards attached to lifelines in conformance with Subpart E of this part.

(3) Buffers shall be provided at both ends of travel of the trolley.

(4) Cranes mounted on rail tracks shall be equipped with limit switches

[4510-26-M]

limiting the travel of the crane on the track and stops or buffers at each end of the tracks.

(5) All hammerhead tower cranes in use shall meet the applicable requirements for design, construction, installation, testing, maintenance, inspection, and operation as prescribed by the manufacturer.

(d) *Overhead and gantry cranes.* (1) The rated load of the crane shall be plainly marked on each side of the crane, and if the crane has more than one hoisting unit, each hoist shall have its rated load marked on it or its load block, and this marking shall be clearly legible from the ground or floor.

(2) Bridge trucks shall be equipped with sweeps which extend below the top of the rail and project in front of the truck wheels.

(3) Except for floor-operated cranes, a gong or other effective audible warning signal shall be provided for each crane equipped with a power traveling mechanism.

(4) All overhead and gantry cranes in use shall meet the applicable requirements for design, construction, installation, testing, maintenance, inspection, and operation as prescribed in the ANSI B30.2.0-1967, Safety Code for Overhead and Gantry Cranes.

(e) *Derricks.* All derricks in use shall meet the applicable requirements for design, construction, installation, inspection, testing, maintenance, and operation as prescribed in American National Standards Institute B30.6-1969, Safety Code for Derricks.

(f) *Floating cranes and derricks*—(1) *Mobile cranes mounted on barges.* (i) When a mobile crane is mounted on a barge, the rated load of the crane shall not exceed the original capacity specified by the manufacturer.

(ii) A load rating chart, with clearly legible letters and figures, shall be provided with each crane, and securely fixed at a location easily visible to the operator.

(iii) When load ratings are reduced to stay within the limits for list of the barge with a crane mounted on it, a new load rating chart shall be provided.

(iv) Mobile cranes on barges shall be positively secured.

(2) *Permanently mounted floating cranes and derricks.* (i) When cranes and derricks are permanently installed on a barge, the capacity and limitations of use shall be based on competent design criteria.

(ii) A load rating chart with clearly legible letters and figures shall be provided and securely fixed at a location easily visible to the operator.

(iii) Floating cranes and floating derricks in use shall meet the applicable requirements for design, construction, installation, testing, maintenance, and operation as prescribed by the manufacturer.

(3) *Protection of employees working on barges.* The employer shall comply with the applicable requirements for protection of employees working onboard marine vessels specified in § 1926.605.

**§ 1926.551 Helicopters.**

(a) *Helicopter regulations.* Helicopter cranes shall be expected to comply with any applicable regulations of the Federal Aviation Administration.

(b) *Briefing.* Prior to each day's operation a briefing shall be conducted. This briefing shall set forth the plan of operation for the pilot and ground personnel.

(c) *Slings and tag lines.* Load shall be properly slung. Tag lines shall be of a length that will not permit their being drawn up into rotors. Pressed sleeve, swedged eyes, or equivalent means shall be used for all freely suspended loads to prevent hand splices from spinning open or cable clamps from loosening.

(d) *Cargo hooks.* All electrically operated cargo hooks shall have the electrical activating device so designed and installed as to prevent inadvertent operation. In addition, these cargo hooks shall be equipped with an emergency mechanical control for releasing the load. The hooks shall be tested prior to each day's operation to determine that the release functions properly, both electrically and mechanically.

(e) *Personal protective equipment.* (1) Personal protective equipment for employees receiving the load shall consist of complete eye protection and hard hats secured by chinstraps.

(2) Loose-fitting clothing likely to flap in the downwash, and thus be snagged on hoist line, shall not be worn.

(f) *Loose gear and objects.* Every practical precaution shall be taken to provide for the protection of the employees from flying objects in the rotor downwash. All loose gear within 100 feet of the place of lifting the load, depositing the load, and all other areas susceptible to rotor downwash shall be secured or removed.

(g) *Housekeeping.* Good housekeeping shall be maintained in all helicopter loading and unloading areas.

(h) *Operator responsibility.* The helicopter operator shall be responsible for size, weight, and manner in which loads are connected to the helicopter. If, for any reason, the helicopter operator believes the lift cannot be made safely, the lift shall not be made.

(i) *Hooking and unhooking loads.* When employees are required to perform work under hovering craft, a safe means of access shall be provided for employees to reach the hoist line hook and engage or disengage cargo slings. Employees shall not perform work under hovering craft except when necessary to hook or unhook loads.

(j) *Static charge.* Static charge on the suspended load shall be dissipated with a grounding device before ground personnel touch the suspended load, or protective rubber gloves shall be worn by all ground personnel touching the suspended load.

(k) *Weight limitation.* The weight of an external load shall not exceed the manufacturer's rating.

(l) *Ground lines.* Hoist wires or other gear, except for pulling lines or conductors that are allowed to "pay out" from a container or roll off a reel, shall not be attached to any fixed ground structure, or allowed to foul on any fixed structure.

(m) *Visibility.* When visibility is reduced by dust or other conditions, ground personnel shall exercise special caution to keep clear of main and stabilizing rotors. Precautions shall also be taken by the employer to eliminate as far as practical reduced visibility.

(n) *Signal systems.* Signal systems between aircrew and ground personnel shall be understood and checked in advance of hoisting the load. This applies to either radio or hand signal systems. Hand signals shall be as shown in Figure N-1.

[4510-26-C]

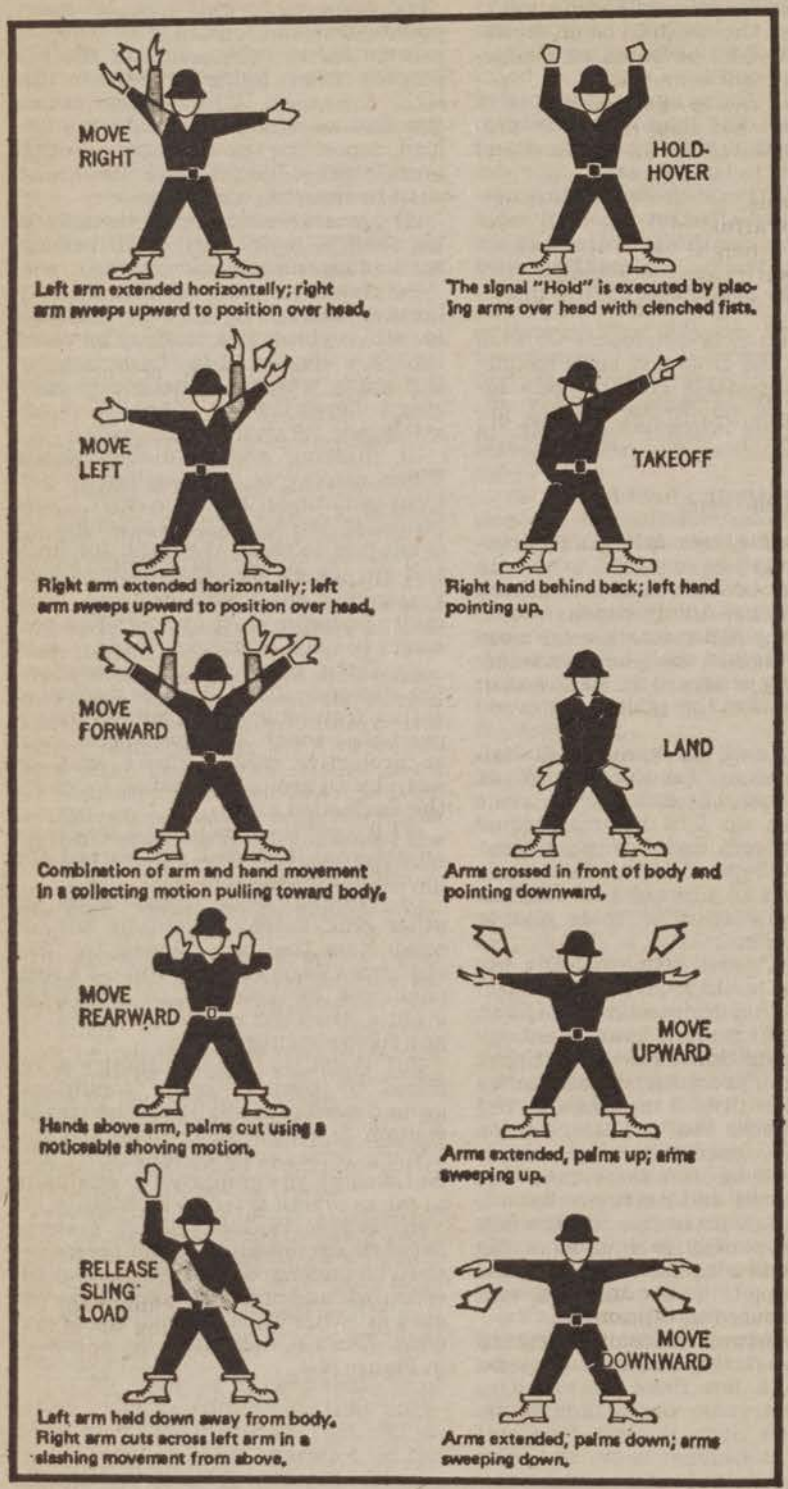



FIGURE N-1 HELICOPTER HAND SIGNAL

(o) *Approach distance.* No unauthorized person shall be allowed to approach within 50 feet of the helicopter when the rotor blades are turning.

(p) *Approaching helicopter.* Whenever approaching or leaving a helicopter with blades rotating, all employees shall remain in full view of the pilot and keep in a crouched position. Employees shall avoid the area from the cockpit or cabin rearward unless authorized by the helicopter operator to work there.

(q) *Personnel.* Sufficient ground personnel shall be provided when required for safe helicopter loading and unloading operations.

(r) *Communications.* There shall be constant reliable communication between the pilot, and a designated employee of the ground crew who acts as a signalman during the period of loading and unloading. This signalman shall be distinctly recognizable from other ground personnel.

(s) *Fires.* Open fires shall not be permitted in an area that could result in such fires being spread by the rotor downwash.

**§ 1926.552 Material hoists, personnel hoists, and elevators.**

(a) *General requirements.* (1) The employer shall comply with the manufacturer's specifications and limitations applicable to the operation of all hoists and elevators. Where manufacturer's specifications are not available, the limitations assigned to the equipment shall be based on the determinations of a professional engineer competent in the field.

(2) Rated load capacities, recommended operating speeds, and special hazard warnings or instructions shall be posted on cars and platforms.

(3) Wire rope shall be removed from service when any of the following conditions exists:

(i) In hoisting ropes, six randomly distributed broken wires in one rope lay or three broken wires in one strand in one rope lay;

(ii) Abrasion, scrubbing, flattening, or peening, causing loss of more than one-third of the original diameter of the outside wires;

(iii) Evidence of any heat damage resulting from a torch or any damage caused by contact with electrical wires;

(iv) Reduction from nominal diameter of more than three sixty-fourths inch for diameters up to and including three-fourths inch; one-sixteenth inch for diameters seven-eights to 1⅛ inches; and three thirty-seconds inch for diameters 1¼ to 1½ inches.

(4) Hoisting ropes shall be installed in accordance with the wire rope manufacturers' recommendations.

(5) The installation of live booms on hoists is prohibited.

(6) The use of endless belt-type manlifts on construction shall be prohibited.

(b) *Material hoists.* (1)(i) Operating rules shall be established and posted at the operator's station of the hoist. Such rules shall include signal system and allowable line speed for various loads. Rules and notices shall be posted on the car frame or crosshead in a conspicuous location, including the statement "No Riders Allowed."

(ii) No person shall be allowed to ride on material hoists except for the purposes of inspection and maintenance.

(2) All entrances of the hoistways shall be protected by substantial gates or bars which shall guard the full width of the landing entrance. All hoistway entrance bars and gates shall be painted with diagonal contrasting colors, such as black and yellow stripes.

(i) Bars shall be not less than 2- by 4-inch wooden bars or the equivalent, located 2 feet from the hoistway line. Bars shall be located not less than 36 inches nor more than 42 inches above the floor.

(ii) Gates or bars protecting the entrances to hoistways shall be equipped with a latching device.

(3) Overhead protective covering of 2-inch planking, ¾-inch plywood, or other solid material of equivalent strength, shall be provided on the top of every material hoist cage or platform.

(4) The operator's station of a hoisting machine shall be provided with overhead protection equivalent to tight planking not less than 2 inches thick. The support for the overhead protection shall be of equal strength.

(5) Hoist towers may be used with or without an enclosure on all sides. However, whichever alternative is chosen, the following applicable conditions shall be met:

(i) When a hoist tower is enclosed, it shall be enclosed on all sides for its entire height with a screen enclosure of ½-inch mesh, No. 18 U.S. gauge wire or equivalent, except for landing access.

(ii) When a hoist tower is not enclosed, the hoist platform or car shall be totally enclosed (caged) on all sides for the full height between the floor and the overhead protective covering with ½-inch mesh of No. 14 U.S. gauge wire or equivalent. The hoist platform enclosure shall include the required gates for loading and unloading. A 6-foot high enclosure shall be provided on the unused sides of the hoist tower at ground level.

(6) Car arresting devices shall be installed to function in case of rope failure.

(7) All material hoist towers shall be designed by a licensed professional engineer.

(8) All material hoists shall conform to the requirements of ANSI A10.5-1969, Safety Requirements for Material Hoists.

(c) *Personnel hoists.* (1) Hoist towers outside the structure shall be enclosed for the full height on the side or sides used for entrance and exit to the structure. At the lowest landing, the enclosure on the sides not used for exit or entrance to the structure shall be enclosed to a height of at least 10 feet. Other sides of the tower adjacent to floors or scaffold platforms shall be enclosed to a height of 10 feet above the level of such floors or scaffolds.

(2) Towers inside of structures shall be enclosed on all four sides throughout the full height.

(3) Towers shall be anchored to the structure at intervals not exceeding 25 feet. In addition to tie-ins, a series of guys shall be installed. Where tie-ins are not practical the tower shall be anchored by means of guys made of wire rope at least one-half inch in diameter, securely fastened to anchorage to ensure stability.

(4) Hoistway doors or gates shall be not less than 6 feet 6 inches high and shall be provided with mechanical locks which cannot be operated from the landing side, and shall be accessible only to persons on the car.

(5) Cars shall be permanently enclosed on all sides and the top, except sides used for entrance and exit which have car gates or doors.

(6) A door or gate shall be provided at each entrance to the car which shall protect the full width and height of the car entrance opening.

(7) Overhead protective covering of 2-inch planking, ¾-inch plywood or other solid material or equivalent strength shall be provided on the top of every personnel hoist.

(8) Doors or gates shall be provided with electric contacts which do not allow movement of the hoist when door or gate is open.

(9) Safeties shall be capable of stopping and holding the car and rated load when traveling at governor tripping speed.

(10) Cars shall be provided with a capacity and data plate secured in a conspicuous place on the car or crosshead.

(11) Internal combustion engines shall not be permitted for direct drive.

(12) Normal and final terminal stopping devices shall be provided.

(13) An emergency stop switch shall be provided in the car and marked "Stop."

(14) Ropes: (i) The minimum number of hoisting ropes used shall be three for traction hoists and two for drum-type hoists.

(ii) The minimum diameter of hoisting and counterweight wire ropes shall be ½-inch.

(iii) Safety factors:

MINIMUM FACTORS OF SAFETY FOR SUSPENSION WIRE ROPES

| Rope speed in feet per minute: | *Minimum factor of safety* |
|---|---|
| 50 | 7.60 |
| 75 | 7.75 |
| 100 | 7.95 |
| 125 | 8.10 |
| 150 | 8.25 |
| 175 | 8.40 |
| 200 | 8.60 |
| 225 | 8.75 |
| 250 | 8.90 |
| 300 | 9.20 |
| 350 | 9.50 |
| 400 | 9.75 |
| 450 | 10.00 |
| 500 | 10.25 |
| 550 | 10.45 |
| 600 | 10.70 |

(15) Following assembly and erection of hoists, and before being put in service, an inspection and test of all functions and safety devices shall be made under the supervision of a competent person. A similar inspection and test is required following major alteration of an existing installation. All hoists shall be inspected and tested at not more than 3-month intervals. Records shall be maintained and kept on file for the duration of the job.

(16) All personnel hoists used by employees shall be constructed of materials and components which meet the specifications for materials, construction, safety devices, assembly, and structural integrity as stated in the American National Standard A10.4-1963, Safety Requirements for Workmen's Hoists. The requirements of this subparagraph (16) do not apply to cantilever type personnel hoists.

(17) (i) Personnel hoists used in bridge tower construction shall be approved by a registered professional engineer and erected under the supervision of a qualified engineer competent in this field.

(ii) When a hoist tower is not enclosed, the hoist platform or car shall be totally enclosed (caged) on all sides for the full height between the floor and the overhead protective covering with ¾-inch mesh of No. 14 U.S. gauge wire or equivalent. The hoist platform enclosure shall include the required gates for loading and unloading.

(iii) These hoists shall be inspected and maintained on a weekly basis. Whenever the hoisting equipment is exposed to winds exceeding 35 miles per hour it shall be inspected and put in operable condition before reuse.

(iv) Wire rope shall be taken out of service when any of the following conditions exist:

(*a*) In running ropes, six randomly distributed broken wires in one lay or three broken wires in one strand in one lay;

(*b*) Wear of one-third the original diameter of outside individual wires. Kinking, crushing, bird caging, or any other damage resulting in distortion of the rope structure;

(c) Evidence of any heat damage from any cause;

(d) Reductions from nominal diameter of more than three-sixty-fourths inch for diameters to and including three-fourths inch, one-sixteenth inch for diameters seven-eights inch to 1⅛ inches inclusive, three-thirty-seconds inch for diameters 1¼ to 1½ inches inclusive;

(e) In standing ropes, more than two broken wires in one lay in sections beyond end connections or more than one broken wire at an end connection.

(d) Permanent elevators under the care and custody of the employer and used by employees for work covered by this Act shall comply with the requirements of American National Standards Institute A17.1-1965 with addenda A17.1a-1967, A17.1b-1968, A17.1c-1969, A17.1d-1970, and inspected in accordance with A17.2-1960 with addenda A17.2a-1965, A17.2b-1967.

**§ 1926.553 Base-mounted drum hoists.**

(a) *General requirements.* (1) Exposed moving parts such as gears, projecting screws, setscrews, chain, cables, chain sprockets, and reciprocating or rotating parts, which constitute a hazard, shall be guarded.

(2) All controls used during the normal operation cycle shall be located within easy reach of the operator's station.

(3) Electric motor operated hoists shall be provided with:

(i) A device to disconnect all motors from the line upon power failure and not permit any motor to be restarted until the controller handle is brought to the "off" position;

(ii) Where applicable, an overspeed preventive device;

(iii) A means whereby remotely operated hoists stop when any control is ineffective.

(4) All base-mounted drum hoists in use shall meet the applicable requirements for design, construction, installation, testing, inspection, maintenance, and operations, as prescribed by the manufacturer.

(b) *Specific requirements.* [Reserved]

**§ 1926.554 Overhead hoists.**

(a) *General requirements.* (1) The safe working load of the overhead hoist, as determined by the manufacturer, shall be indicated on the hoist, and this safe working load shall not be exceeded.

(2) The supporting structure to which the hoist is attached shall have a safe working load equal to that of the hoist.

(3) The support shall be arranged so as to provide for free movement of the hoist and shall not restrict the hoist from lining itself up with the load.

(4) The hoist shall be installed only in locations that will permit the operator to stand clear of the load at all times.

(5) Air hoists shall be connected to an air supply of sufficient capacity and pressure to safely operate the hoist. All air hoses supplying air shall be positively connected to prevent their becoming disconnected during use.

(6) All overhead hoists in use shall meet the applicable requirements for construction, design, installation, testing, inspection, maintenance, and operation, as prescribed by the manufacturer.

(b) *Specific requirements.* [Reserved]

**§ 1926.555 Conveyors.**

(a) *General requirements.* (1) Means for stopping the motor or engine shall be provided at the operator's station. Conveyor systems shall be equipped with an audible warning signal to be sounded immediately before starting up the conveyor.

(2) If the operator's station is at a remote point, similar provisions for stopping the motor or engine shall be provided at the motor or engine location.

(3) Emergency stop switches shall be arranged so that the conveyor cannot be started again until the actuating stop switch has been reset to running or "on" position.

(4) Screw conveyors shall be guarded to prevent employee contact with turning flights.

(5) Where a conveyor passes over work areas, aisles, or thoroughfares, suitable guards shall be provided to protect employees required to work below the conveyors.

(6) All crossovers, aisles, and passageways shall be conspicuously marked by suitable signs, as required by Subpart G of this part.

(7) Conveyors shall be locked out or otherwise rendered inoperable, and tagged out with a "Do Not Operate" tag during repairs and when operation is hazardous to employees performing maintenance work.

(8) All conveyors in use shall meet the applicable requirements for design, construction, inspection, testing, maintenance, and operation, as prescribed in the ANSI B20.1-1957, Safety Code for Conveyors, Cableways, and Related Equipment.

**§ 1926.556 Aerial lifts.**

(a) *General requirements.* (1) Unless otherwise provided in this section, aerial lifts acquired for use on or after the effective date of this section shall be designed and constructed in conformance with the applicable requirements of the American National Standard for "Vehicle Mounted Elevating and Rotating Work Platforms," ANSI A92.2-1969, including appendix. Aerial lifts acquired before the effective date of this section, which do not meet the requirements of ANSI A92.2-1969, may not be used after January 1, 1976, unless they shall have been modified so as to conform with the applicable design and construction requirements of ANSI A92.2-1969. Aerial lifts include the following types of vehicle-mounted aerial devices used to elevate personnel to jobsites above ground:

(i) Extensible boom platforms;

(ii) Aerial ladders;

(iii) Articulating boom platforms;

(iv) Vertical towers; and

(v) A combination of any of the above.

Aerial equipment may be made of metal, wood, fiberglass reinforced plastic (FRP), or other material; may be powered or manually operated; and are deemed to be aerial lifts whether or not they are capable of rotating about a substantially vertical axis.

(2) Aerial lifts may be "field modified" for uses other than those intended by the manufacturer provided the modification has been certified in writing by the manufacturer or by any other equivalent entity, such as a nationally recognized testing laboratory, to be in conformity with all applicable provisions of ANSI A92.2-1969 and this section and to be at least as safe as the equipment was before modification.

(b) *Specific requirements*—(1) *Ladder trucks and tower trucks.* Aerial ladders shall be secured in the lower traveling position by the locking device on top of the truck cab, and the manually operated device at the base of the ladder before the truck is moved for highway travel.

(2) *Extensible and articulating boom platforms.* (i) Lift controls shall be tested each day prior to use to determine that such controls are in safe working condition.

(ii) Only authorized persons shall operate an aerial lift.

(iii) Belting off to an adjacent pole, structure, or equipment while working from an aerial lift shall not be permitted.

(iv) Employees shall always stand firmly on the floor of the basket, and shall not sit or climb on the edge of the basket or use planks, ladders, or other devices for a work position.

(v) A body belt shall be worn and a lanyard attached to the boom or basket when working from an aerial lift.

(vi) Boom and basket load limits specified by the manufacturer shall not be exceeded.

(vii) The brakes shall be set and when outriggers are used, they shall be positioned on pads or a solid sur-

face. Wheel chocks shall be installed before using an aerial lift on an incline, provided they can be safely installed.

(viii) An aerial lift truck shall not be moved when the boom is elevated in a working position with men in the basket, except for equipment which is specifically designed for this type of operation in accordance with the provisions of subparagraphs (1) and (2) of paragraph (a) of this section.

(ix) Articulating boom and extensible boom platforms, primarily designed as personnel carriers, shall have both platform (upper) and lower controls. Upper controls shall be in or beside the platform within easy reach of the operator. Lower controls shall provide for overriding the upper controls. Controls shall be plainly marked as to their function. Lower level controls shall not be operated unless permission has been obtained from the employee in the lift, except in case of emergency.

(x) Climbers shall not be worn while performing work from an aerial lift.

(xi) The insulated portion of an aerial lift shall not be altered in any manner that might reduce its insulating value.

(xii) Before moving an aerial lift for travel, the boom(s) shall be inspected to see that it is properly cradled and outriggers are in stowed position except as provided in subdivision (viii) of this subparagraph.

(3) *Electrical tests.* All electrical tests shall conform to the requirements of ANSI A92.2-1969 section 5. However equivalent d.c. voltage tests may be used in lieu of the a.c. voltage specified in A92.2-1969; d.c. voltage tests which are approved by the equipment manufacturer or equivalent entity shall be considered an equivalent test for the purpose of this subparagraph (3).

(4) *Bursting safety factor.* The provisions of the American National Standards Institute standard ANSI A92.2-1969, section 4.9 Bursting Safety Factor shall apply to all critical hydraulic and pneumatic components. Critical components are those in which a failure would result in a free fall or free rotation of the boom. All noncritical components shall have a bursting safety factor of at least 2 to 1.

(5) *Welding standards.* All welding shall conform to the following standards as applicable:

(i) Standard Qualification Procedure, AWS B3.0-41.

(ii) Recommended Practices for Automotive Welding Design, AWS D8.4-61.

(iii) Standard Qualification of Welding Procedures and Welders for Piping and Tubing, AWS D10.9-69.

(iv) Specifications for Welding Highway and Railway Bridges, AWS D2.0-69.

## Subpart O—Motor Vehicles, Mechanized Equipment, and Marine Operations [1]

Sec.

1926.600 Equipment.
*1910.176 Handling materials—general.*
*1910.169 Air receivers.*
1926.601 Motor vehicles.
1926.602 Material handling equipment.
1926.603 Pile driving equipment.
1926.604 Site clearing.
1926.605 Marine operations and equipment.
1926.606 Definitions applicable to this subpart.

### § 1926.600 Equipment.

(a) *General requirements.* (1) All equipment left unattended at night, adjacent to a highway in normal use, or adjacent to construction areas where work is in progress, shall have appropriate lights or reflectors, or barricades equipped with appropriate lights or reflectors, to identify the location of the equipment.

(2) A safety tire rack, cage, or equivalent protection shall be provided and used when inflating, mounting, or dismounting tires installed on split rims, or rims equipped with locking rings or similar devices.

(3) (i) Heavy machinery, equipment, or parts thereof, which are suspended or held aloft by use of slings, hoists, or jacks shall be substantially blocked or cribbed to prevent falling or shifting before employees are permitted to work under or between them. Bulldozer and scraper blades, end-loader buckets, dump bodies, and similar equipment, shall be either fully lowered or blocked when being repaired or when not in use. All controls shall be in a neutral position, with the motors stopped and brakes set, unless work being performed requires otherwise.

(ii) Whenever the equipment is parked, the parking brake shall be set. Equipment parked on inclines shall have the wheels chocked and the parking brake set.

(4) The use, care and charging of all batteries shall conform to the requirements of Subpart K of this part.

(5) All cab glass shall be safety glass, or equivalent, that introduces no visible distortion affecting the safe operation of any machine covered by this subpart.

(6) All equipment covered by this subpart shall comply with the requirements of § 1518.550(a)(15) when working or being moved in the vicinity of power lines or energized transmitters.

(b) *Specific requirements.* [Reserved]

[1] Portions of the listed Part 1910 standards have been identified as applicable to construction.

The following requirements from 29 CFR Part 1910 (General Industry) have been identified as applicable to construction (29 CFR 1926.600 *Equipment*), an accordance with the scope noted below.

### § 1910.176 Handling materials—general.

* * * * *

(f) *Rolling railroad cars.* Derail and/or bumper blocks shall be provided on spur railroad tracks where a rolling car could contact other cars being worked, enter a building, work or traffic area.

* * * * *

### § 1910.169 Air receivers.

(a) *General requirements*—(1) *Application.* This section applies to compressed air receivers, and other equipment used in providing and utilizing compressed air for performing operations such as cleaning, drilling, hoisting, and chipping. On the other hand, however, this section does not deal with the special problems created by using compressed air to convey materials nor the problems created when men work in compressed air as in tunnels and caissons. This section is not intended to apply to compressed air machinery and equipment used on transportation vehicles such as steam railroad cars, electric railway cars, and automotive equipment.

(2) *New and existing equipment* (i) All new air receivers installed after the effective date of these regulations shall be constructed in accordance with the 1968 edition of the A.S.M.E. Boiler and Pressure Vessel Code Section VIII.

(ii) All safety valves used shall be constructed, installed, and maintained in accordance with the A.S.M.E. Boiler and Pressure Vessel Code, Section VIII Edition 1968.

(b) *Installation and equipment requirements*—(1) *Installation.* Air receivers shall be so installed that all drains, handholes, and manholes therein are easily accessible. Air receivers should be supported with sufficient clearance to permit a complete external inspection and to avoid corrosion of external surfaces. Under no circumstances shall an air receiver be buried underground or located in an inaccessible place. The receiver should be located as close to the compressor or aftercooler as is possible in order to keep the discharge pipe short.

(2) *Drains and traps.* A drain pipe and valve shall be installed at

the lowest point of every air receiver to provide for the removal of accumulated oil and water. Adequate automatic traps may be installed in addition to drain valves. The drain valve on the air receiver shall be opened and the receiver completely drained frequently and at such intervals as to prevent the accumulation of excessive amounts of liquid in the receiver.

(3) *Gages and valves.* (i) Every air receiver shall be equipped with an indicating pressure gage (so located as to be readily visible) and with one or more spring-loaded safety valves. The total relieving capacity of such safety valves shall be such as to prevent pressure in the receiver from exceeding the maximum allowable working pressure of the receiver by more than 10 percent.

(ii) No valve of any type shall be placed between the air receiver and its safety valve or valves.

(iii) Safety appliances, such as safety valves, indicating devices and controlling devices, shall be constructed, located, and installed so that they cannot be readily rendered inoperative by any means, including the elements.

(iv) All safety valves shall be tested frequently and at regular intervals to determine whether they are in good operating condition.

---

**§ 1926.601 Motor vehicles.**

(a) *Coverage.* Motor vehicles as covered by this part are those vehicles that operate within an off-highway jobsite, not open to public traffic. The requirements of this section do not apply to equipment for which rules are prescribed in § 1926.602.

(b) *General requirements.* (1) All vehicles shall have a service brake system, an emergency brake system, and a parking brake system. These systems may use common components, and shall be maintained in operable condition.

(2)(i) Whenever visibility conditions warrant additional light, all vehicles, or combinations of vehicles, in use shall be equipped with at least two headlights and two taillights in operable condition.

(ii) All vehicles, or combination of vehicles, shall have brake lights in operable condition regardless of light conditions.

(3) All vehicles shall be equipped with an adequate audible warning device at the operator's station and in an operable condition.

(4) No employer shall use any motor vehicle equipment having an obstructed view to the rear unless:

(i) The vehicle has a reverse signal alarm audible above the surrounding noise level; or

(ii) The vehicle is backed up only when an observer signals that it is safe to do so.

(5) All vehicles with cabs shall be equipped with windshields and powered wipers. Cracked and broken glass shall be replaced. Vehicles operating in areas or under conditions that cause fogging or frosting of the windshields shall be equipped with operable defogging or defrosting devices.

(6) All haulage vehicles, whose pay load is loaded by means of cranes, power shovels, loaders, or similar equipment, shall have a cab shield and/or canopy adequate to protect the operator from shifting or falling materials.

(7) Tools and material shall be secured to prevent movement when transported in the same compartment with employees.

(8) Vehicles used to transport employees shall have seats firmly secured and adequate for the number of employees to be carried.

(9) Seat belts and anchorages meeting the requirements of 49 CFR Part 571 (Department of Transportation, Federal Motor Vehicle Safety Standards) shall be installed in all motor vehicles.

(10) Trucks with dump bodies shall be equipped with positive means of support, permanently attached, and capable of being locked in position to prevent accidental lowering of the body while maintenance or inspection work is being done.

(11) Operating levers controlling hoisting or dumping devices on haulage bodies shall be equipped with a latch or other device which will prevent accidental starting or tripping of the mechanism.

(12) Trip handles for tailgates of dump trucks shall be so arranged that, in dumping, the operator will be in the clear.

(13) (i) All rubber-tired motor vehicle equipment manufactured on or after May 1, 1972, shall be equipped with fenders. All rubber-tired motor vehicle equipment manufactured before May 1, 1972, shall be equipped with fenders not later than May 1, 1973.

(ii) Mud flaps may be used in lieu of fenders whenever motor vehicle equipment is not designed for fenders.

(14) All vehicles in use shall be checked at the beginning of each shift to assure that the following parts, equipment, and accessories are in safe operating condition and free of apparent damage that could cause failure while in use: service brakes, including trailer brake connections; parking system (hand brake); emergency stopping system (brakes); tires; horn; steering mechanism; coupling devices; seat belts; operating controls; and safety devices. All defects shall be corrected before the vehicle is placed in service. These requirements also apply to equipment such as lights, reflectors, windshield wipers, defrosters, fire extinguishers, etc., where such equipment is necessary.

**§ 1926.602 Material handling equipment.**

(a) *Earthmoving equipment; General* (1) These rules apply to the following types of earthmoving equipment: scrapers, loaders, crawler or wheel tractors, bulldozers, off-highway trucks, graders, agricultural and industrial tractors, and similar equipment. The promulgation of specific rules for compactors and rubber-tired "skid-steer" equipment is reserved pending consideration of standards currently being developed.

(2) *Seat belts.* (i) Seat belts shall be provided on all equipment covered by this section and shall meet the requirements of the Society of Automotive Engineers, J386-1969, Seat Belts for Construction Equipment. Seat belts for agricultural and light industrial tractors shall meet the seat belt requirements of Society of Automotive Engineers J333a-1970, Operator Protection for Agricultural and Light Industrial Tractors.

(ii) Seat belts need not be provided for equipment which is designed only for standup operation.

(iii) Seat belts need not be provided for equipment which does not have roll-over protective structure (ROPS) or adequate canopy protection.

(3) *Access roadways and grades.* (i) No employer shall move or cause to be moved construction equipment or vehicles upon any access roadway or grade unless the access roadway or grade is constructed and maintained to accommodate safely the movement of the equipment and vehicles involved.

(ii) Every emergency access ramp and berm used by an employer shall be constructed to restrain and control runaway vehicles.

(4) *Brakes.* All earthmoving equipment mentioned in this § 1926.602(a) shall have a service braking system capable of stopping and holding the equipment fully loaded, as specified in Society of Automotive Engineers SAE-J237, Loader Dozer-1971, J236, Graders-1971, and J319b, Scrapers-1971. Brake systems for self-propelled rubber-tired off-highway equipment manufactured after January 1, 1972 shall meet the applicable minimum performance criteria set forth in the following Society of Automotive Engineers Recommended Practices:

| | |
|---|---|
| Self-Propelled Scrapers | SAE J319b-1971 |
| Self-Propelled Graders | SAE J236-1971 |
| Trucks and Wagons | SAE J166-1971 |
| Front End Loaders and Dozers | SAE J237-1971 |

(5) *Fenders.* Pneumatic-tired earthmoving haulage equipment (trucks, scrapers, tractors, and trailing units) whose maximum speed exceeds 15 miles per hour, shall be equipped with fenders on all wheels to meet the requirements of Society of Automotive Engineers SAE J321a-1970, Fenders for Pneumatic-Tired Earthmoving Haulage Equipment. An employer may, of course, at any time seek to show under § 1926.2, that the uncovered wheels present no hazard to personnel from flying materials.

(6) *Rollover protective structures (ROPS).* See Subpart W of this part for requirements for rollover protective structures and overhead protection.

(7) *Rollover protective structures for off-highway trucks.* The promulgation of standards for rollover protective structures for off-highway trucks is reserved pending further study and development.

(8) *Specific effective dates—brakes and fenders.* (i) Equipment mentioned in subparagraphs (4) and (5) of this paragraph, and manufactured after January 1, 1972, which is used by any employer after that date, shall comply with the applicable rules prescribed therein concerning brakes and fenders. Equipment mentioned in subparagraph (4) and (5) of this paragraph, and manufactured before January 1, 1972, which is used by any employer after that date, shall meet the applicable rules prescribed herein not later than June 30, 1973. It should be noted that, as permitted under § 1926.2, employers may request variations from the applicable brakes and fender standards required by this subpart. Employers wishing to seek variations from the applicable brakes and fenders rules may submit any requests for variations after the publication of this document in the FEDERAL REGISTER. Any statements intending to meet the requirements of § 1926.2(b)(4), should specify how the variation would protect the safety of the employees by providing for any compensating restrictions on the operation of equipment.

(ii) Notwithstanding the provisions of paragraph (a)(8)(i) of this section, the requirement that fenders be installed on pneumatic-tired earthmoving haulage equipment manufactured before January 1, 1972, shall take effect on January 2, 1974.

(9) *Audible alarms.* (i) All bidirectional machines, such as rollers, compacters, front-end loaders, bulldozers, and similar equipment, shall be equipped with a horn, distinguishable from the surrounding noise level, which shall be operated as needed when the machine is moving in either direction. The horn shall be maintained in an operative condition.

(ii) No employer shall permit earthmoving or compacting equipment which has an obstructed view to the rear to be used in reverse gear unless the equipment has in operation a reverse signal alarm distinguishable from the surrounding noise level or an employee signals that it is safe to do so.

(10) *Scissor points.* Scissor points on all front-end loaders, which constitute a hazard to the operator during normal operation, shall be guarded.

(b) *Excavating and other equipment.* (1) Tractors covered in paragraph (a) of this section shall have seat belts as required for the operators when seated in the normal seating arrangement for tractor operation, even though back-hoes, breakers, or other similar attachments are used on these machines for excavating or other work.

(2) For the purposes of this subpart and of Subpart N of this part, the nomenclatures and descriptions for measurement of dimensions of machinery and attachments shall be as described in Society of Automotive Engineers 1970 Handbook, pages 1088 through 1103.

(3) The safety requirements, ratios, or limitations applicable to machines or attachment usage covered in Power Crane and Shovel Associations Standards No. 1 and No. 2 of 1968, and No. 3 of 1969, shall be complied with, and shall apply to cranes, machines, and attachments under this part.

(c) *Lifting and hauling equipment (other than equipment covered under Subpart N of this part).* (1) Industrial trucks shall meet the requirements of § 1926.600 and the following:

(i) Lift trucks, stackers, etc., shall have the rated capacity clearly posted on the vehicle so as to be clearly visible to the operator. When auxiliary removable counterweights are provided by the manufacturer, corresponding alternate rated capacities also shall be clearly shown on the vehicle. These ratings shall not be exceeded.

(ii) No modifications or additions which affect the capacity or safe operation of the equipment shall be made without the manufacturer's written approval. If such modifications or changes are made, the capacity, operation, and maintenance instruction plates, tags, or decals shall be changed accordingly. In no case shall the original safety factor of the equipment be reduced.

(iii) If a load is lifted by two or more trucks working in unison, the proportion of the total load carried by any one truck shall not exceed its capacity.

(iv) Steering or spinner knobs shall not be attached to the steering wheel unless the steering mechanism is of a type that prevents road reactions from causing the steering handwheel to spin. The steering knob shall be mounted within the periphery of the wheel.

(v) All high lift rider industrial trucks shall be equipped with overhead guards which meet the configuration and structural requirements as defined in paragraph 421 of American National Standards Institute B56.1-1969, Safety Standards for Powered Industrial Trucks.

(vi) All industrial trucks in use shall meet the applicable requirements of design, construction, stability, inspection, testing, maintenance, and operation, as defined in American National Standards Institute B56.1-1969, Safety Standards for Powered Industrial Trucks.

**§ 1926.603 Pile driving equipment.**

(a) *General requirements.* (1) Boilers and piping systems which are a part of, or used with, pile driving equipment shall meet the applicable requirements of the American Society of Mechanical Engineers, Power Boilers (section I).

(2) All pressure vessels which are a part of, or used with, pile driving equipment shall meet the applicable requirements of the American Society of Mechanical Engineers, Pressure Vessels (section VIII).

(3) Overhead protection, which will not obscure the vision of the operator and which meets the requirements of Subpart N of this part, shall be provided. Protection shall be the equivalent of 2-inch planking or other solid material of equivalent strength.

(4) Stop blocks shall be provided for the leads to prevent the hammer from being raised against the head block.

(5) A blocking device, capable of safely supporting the weight of the hammer, shall be provided for placement in the leads under the hammer at all times while employees are working under the hammer.

(6) Guards shall be provided across the top of the head block to prevent the cable from jumping out of the sheaves.

(7) When the leads must be inclined in the driving of batter piles, provisions shall be made to stabilize the leads.

(8) Fixed leads shall be provided with ladder, and adequate rings, or similar attachment points, so that the loft worker may engage his safety belt lanyard to the leads. If the leads are provided with loft platforms(s), such platform(s) shall be protected by standard guardrails.

(9) Steam hose leading to a steam hammer or jet pipe shall be securely attached to the hammer with an adequate length of at least ¼-inch diameter chain or cable to prevent whipping in the event the joint at the hammer is broken. Air hammer hoses shall be

provided with the same protection as required for steam lines.

(10) Safety chains, or equivalent means, shall be provided for each hose connection to prevent the line from thrashing around in case the coupling becomes disconnected.

(11) Steam line controls shall consist of two shutoff valves, one of which shall be a quick-acting lever type within easy reach of the hammer operator.

(12) Guys, outriggers, thrustouts, or counterbalances shall be provided as necessary to maintain stability of pile driver rigs.

(b) *Pile driving from barges and floats.* Barges or floats supporting pile driving operations shall meet the applicable requirements of § 1926.605.

(c) *Pile driving equipment.* (1) Engineers and winchmen shall accept signals only from the designated signalmen.

(2) All employees shall be kept clear when piling is being hoisted into the leads.

(3) When piles are being driven in an excavated pit, the walls of the pit shall be sloped to the angle of repose or sheet-piled and braced.

(4) When steel tube piles are being "blown out", employees shall be kept well beyond the range of falling materials.

(5) When it is necessary to cut off the tops of driven piles, pile driving operations shall be suspended except where the cutting operations are located at least twice the length of the longest pile from the driver.

(6) When driving jacked piles, all access pits shall be provided with ladders and bulkheaded curbs to prevent material from falling into the pit.

**§ 1926.604 Site clearing.**

(a) *General requirements.* (1) Employees engaged in site clearing shall be protected from hazards of irritant and toxic plants and suitably instructed in the first aid treatment available.

(2) All equipment used in site clearing operations shall be equipped with rollover guards meeting the requirements of this subpart. In addition, rider-operated equipment shall be equipped with an overhead and rear canopy guard meeting the following requirements:

(i) The overhead covering on this canopy structure shall be of not less than ⅛-inch steel plate or ¼-inch woven wire mesh with openings no greater than 1 inch, or equivalent.

(ii) The opening in the rear of the canopy structure shall be covered with not less than ¼-inch woven wire mesh with openings no greater than 1 inch.

(b) *Specific requirements.* [Reserved]

**§ 1926.605 Marine operations and equipment.**

(a) *Material handling operations.* (1) Operations fitting the definition of "material handling" shall be performed in conformance with applicable requirements of Part 1918, "Safety and Health Regulations for Longshoring" of this chapter. The term "longshoring operations" means the loading, unloading, moving, or handling of construction materials, equipment and supplies, etc. into, in, on, or out of any vessel from a fixed structure or shore-to-vessel, vessel-to-shore or fixed structure or vessel-to-vessel.

(b) *Access to barges.* (1) Ramps for access of vehicles to or between barges shall be of adequate strength, provided with side boards, well maintained, and properly secured.

(2) Unless employees can step safely to or from the wharf, float, barge, or river towboat, either a ramp, meeting the requirements of subparagraph (1) of this paragraph, or a safe walkway, shall be provided.

(3) Jacob's ladders shall be of the double rung or flat tread type. They shall be well maintained and properly secured.

(4) A Jacob's ladder shall either hang without slack from its lashings or be pulled up entirely.

(5) When the upper end of the means of access rests on or is flush with the top of the bulwark, substantial steps properly secured and equipped with at least one substantial hand rail approximately 33 inches in height, shall be provided between the top of the bulwark and the deck.

(6) Obstructions shall not be laid on or across the gangway.

(7) The means of access shall be adequately illuminated for its full length.

(8) Unless the structure makes it impossible, the means of access shall be so located that the load will not pass over employees.

(c) *Working surfaces of barges.* (1) Employees shall not be permitted to walk along the sides of covered lighters or barges with coamings more than 5 feet high, unless there is a 3-foot clear walkway, or a grab rail, or a taut handline is provided.

(2) Decks and other working surfaces shall be maintained in a safe condition.

(3) Employees shall not be permitted to pass fore and aft, over, or around deckloads, unless there is a safe passage.

(4) Employees shall not be permitted to walk over deckloads from rail to coaming unless there is a safe passage. If it is necessary to stand at the outboard or inboard edge of the deckload where less than 24 inches of bulwark, rail, coaming, or other protection exists, all employees shall be provided with a suitable means of protection against falling from the deckload.

(d) *First-aid and lifesaving equipment.* (1) Provisions for rendering first aid and medical assistance shall be in accordance with Subpart D of this part.

(2) The employer shall ensure that there is in the vicinity of each barge in use at least one U.S. Coast Guard-approved 30-inch lifering with not less than 90 feet of line attached, and at least one portable or permanent ladder which will reach the top of the apron to the surface of the water. If the above equipment is not available at the pier, the employer shall furnish it during the time that he is working the barge.

(3) Employees walking or working on the unguarded decks of barges shall be protected with U.S. Coast Guard-approved work vests or buoyant vests.

(e) *Diving operations.* Commercial diving operations shall be subject to Subpart T of Part 1910, §§ 1910.401–1910.441, of this chapter.

NOTE: See Subpart T, reprinted immediately following the Part 1926 standards.

**§ 1926.606 Definitions applicable to this subpart.**

(a) "Apron"—The area along the waterfront edge of the pier or wharf.

(b) "Bulwark"—The side of a ship above the upper deck.

(c) "Coaming"—The raised frame, as around a hatchway in the deck, to keep out water.

(d) "Jacob's ladder"—A marine ladder of rope or chain with wooden or metal rungs.

(e) "Rail", for the purpose of § 1926.605, means a light structure serving as a guard at the outer edge of a ship's deck.

## Subpart P—Excavations, Trenching, and Shoring

1926.650 General protection requirements.
1926.651 Specific excavation requirements.
1926.652 General trenching requirements.
1926.653 Definitions applicable to this subpart.

**§ 1926.650 General protection requirements.**

(a) Walkways, runways, and sidewalks shall be kept clear of excavated material or other obstructions and no sidewalks shall be undermined unless shored to carry a minimum live load of one hundred and twenty-five (125) pounds per square foot.

(b) If planks are used for raised walkways, runways, or sidewalks, they shall be laid parallel to the length of the walk and fastened together against displacement.

(c) Planks shall be uniform in thickness and all exposed ends shall be provided with beveled cleats to prevent tripping.

(d) Raised walkways, runways, and sidewalks shall be provided with plank steps on strong stringers. Ramps, used in lieu of steps, shall be provided with cleats to insure a safe walking surface.

(e) All employees shall be protected with personal protective equipment for the protection of the head, eyes, respiratory organs, hands, feet, and other parts of the body as set forth in Subpart E of this part.

(f) Employees exposed to vehicular traffic shall be provided with and shall be instructed to wear warning vests marked with or made of reflectorized or high visibility material.

(g) Employees subjected to hazardous dusts, gases, fumes, mists, or atmospheres deficient in oxygen, shall be protected with approved respiratory protection as set forth in Subpart D of this part.

(h) No person shall be permitted under loads handled by power shovels, derricks, or hoists. To avoid any spillage employees shall be required to stand away from any vehicle being loaded.

(i) Daily inspections of excavations shall be made by a competent person. If evidence of possible cave-ins or slides is apparent, all work in the excavation shall cease until the necessary precautions have been taken to safeguard the employees.

**§ 1926.651 Specific excavation requirements.**

(a) Prior to opening an excavation, effort shall be made to determine whether underground installations; i.e., sewer, telephone, water, fuel, electric lines, etc.; will be encountered, and if so, where such underground installations are located. When the excavation approaches the estimated location of such an installation, the exact location shall be determined and when it is uncovered, proper supports shall be provided for the existing installation. Utility companies shall be contacted and advised of proposed work prior to the start of actual excavation.

(b) Trees, boulders, and other surface encumbrances, located so as to create a hazard to employees involved in excavation work or in the vicinity thereof at any time during operations, shall be removed or made safe before excavating is begun.

(c) The walls and faces of all excavations in which employees are exposed to danger from moving ground shall be guarded by a shoring system, sloping of the ground, or some other equivalent means.

(d) Excavations shall be inspected by a competent person after every rainstorm or other hazard-increasing occurrence, and the protection against slides and cave-ins shall be increased if necessary.

(e) The determination of the angle of repose and design of the supporting system shall be based on careful evaluation of pertinent factors such as: Depth or cut; possible variation in water content of the material while the excavation is open; anticipated changes in materials from exposure to air, sun, water, or freezing; loading imposed by structures, equipment, overlying material, or stored material; and vibration from equipment, blasting, traffic, or other sources.

(f) Supporting systems; i.e., piling, cribbing, shoring, etc., shall be designed by a qualified person and meet accepted engineering requirements. When tie rods are used to restrain the top of sheeting or other retaining systems, the rods shall be securely anchored well back of the angle of repose. When tight sheeting or sheet piling is used, full loading due to ground water table shall be assumed, unless prevented by weep holes or drains or other means. Additional stringers, ties, and bracing shall be provided to allow for any necessary temporary removal of individual supports.

(g) All slopes shall be excavated to at least the angle of repose except for areas where solid rock allows for line drilling or presplitting.

(h) The angle of repose shall be flattened when an excavation has water conditions, silty materials, loose boulders, and areas where erosion, deep frost action, and slide planes appear.

(i)(1) In excavations which employees may be required to enter, excavated or other material shall be effectively stored and retained at least 2 feet or more from the edge of the excavation.

(2) As an alternative to the clearance prescribed in subparagraph (1) of this paragraph, the employer may use effective barriers or other effective retaining devices in lieu thereof in order to prevent excavated or other materials from falling into the excavation.

(j) Sides, slopes, and faces of all excavations shall meet accepted engineering requirements by scaling, benching, barricading, rock bolting, wire meshing, or other equally effective means. Special attention shall be given to slopes which may be adversely affected by weather or moisture content.

(k) Support systems shall be planned and designed by a qualified person when excavation is in excess of 20 feet in depth, adjacent to structures or improvements, or subject to vibration or ground water.

(l) Materials used for sheeting, sheet piling, cribbing, bracing, shoring, and underpinning shall be in good serviceable condition, and timbers shall be sound, free from large or loose knots, and of proper dimensions.

(m) Special precations shall be taken in sloping or shoring the sides of excavations adjacent to a previously backfilled excavation or a fill, particularly when the separation is less than the depth of the excavation. Particular attention also shall be paid to joints and seams of material comprising a face and the slope of such seams and joints.

(n) Except in hard rock, excavations below the level of the base of footing of any foundation or retaining wall shall not be permitted, unless the wall is underpinned and all other precautions taken to insure the stability of the adjacent walls for the protection of employees involved in excavation work or in the vicinity thereof.

(o) If the stability of adjoining buildings or walls is endangered by excavations, shoring, bracing, or underpinning shall be provided as necessary to insure their safety. Such shoring, bracing, or underpinning shall be inspected daily or more often, as conditions warrant, by a competent person and the protection effectively maintained.

(p) Diversion ditches, dikes, or other suitable means shall be used to prevent surface water from entering an excavation and to provide adequate drainage of the area adjacent to the excavation. Water shall not be allowed to accumulate in an excavation.

(q) If it is necessary to place or operate power shovels, derricks, trucks, materials, or other heavy objects on a level above and near an excavation, the side of the excavation shall be sheet-piled, shored, and braced as necessary to resist the extra pressure due to such superimposed loads.

(r) Blasting and the use of explosives shall be performed in accordance with Subpart U of this part.

(s) When mobile equipment is utilized or allowed adjacent to excavations, substantial stop logs or barricades shall be installed. If possible, the grade should be away from the excavation.

(t) Adequate barrier physical protection shall be provided at all remotely located excavations. All wells, pits, shafts, etc., shall be barricaded or covered. Upon completion of exploration and similar operations, temporary wells, pits, shafts, etc., shall be backfilled.

(u) If possible, dust conditions shall be kept to a minimum by the use of water, salt, calcium chloride, oil, or other means.

(v) In locations where oxygen deficiency or gaseous conditions are possible, air in the excavation shall be tested. Controls, as set forth in Subparts D and E of this part, shall be established to assure acceptable atmospheric conditions. When flammable gases are present, adequate ventilation

shall be provided or sources of ignition shall be eliminated. Attended emergency rescue equipment, such as breathing apparatus, a safety harness and line, basket stretcher, etc., shall be readily available where adverse atmospheric conditions may exist or develop in an excavation.

(w) Where employees or equipment are required or permitted to cross over excavations, walkways or bridges with standard guardrails shall be provided.

(x) Where ramps are used for employees or equipment, they shall be designed and constructed by qualified persons in accordance with accepted engineering requirements.

(y) All ladders used on excavation operations shall be in accordance with the requirements of Subpart L of this part.

**§ 1926.652 Specific trenching requirements.**

(a) Banks more than 5 feet high shall be shored, laid back to a stable slope, or some other equivalent means of protection shall be provided where employees may be exposed to moving ground or cave-ins. Refer to Table P-1 as a guide in sloping of banks. Trenches less than 5 feet in depth shall also be effectively protected when examination of the ground indicates hazardous ground movement may be expected.

(b) Sides of trenches in unstable or soft material, 5 feet or more in depth, shall be shored, sheeted, braced, sloped, or otherwise supported by means of sufficient strength to protect the employees working within them. See Tables P-1, P-2 (following paragraph (g) of this section).

(c) Sides of trenches in hard or compact soil, including embankments, shall be shored or otherwise supported when the trench is more than 5 feet in depth and 8 feet or more in length. In lieu of shoring, the sides of the trench above the 5-foot level may be sloped to preclude collapse, but shall not be steeper than a 1-foot rise to each ½-foot horizontal. When the outside diameter of a pipe is greater than 6 feet, a bench of 4-foot minimum shall be provided at the toe of the sloped portion.

(d) Materials used for sheeting and sheet piling, bracing, shoring, and underpinning, shall be in good serviceable condition, and timbers used shall be sound and free from large or loose knots, and shall be designed and installed so as to be effective to the bottom of the excavation.

(e) Additional precautions by way of shoring and bracing shall be taken to prevent slides or cave-ins when excavations or trenches are made in locations adjacent to backfilled excavations, or where excavations are subjected to vibrations from railroad or highway traffic, the operation of machinery, or any other source.

(f) Employees entering bell-bottom pier holes shall be protected by the installation of a removable-type casing of sufficient strength to resist shifting of the surrounding earth. Such temporary protection shall be provided for the full depth of that part of each pier hole which is above the bell. A lifeline, suitable for instant rescue and securely fastened to a shoulder harness, shall be worn by each employee entering the shafts. This lifeline shall be individually manned and separate from any line used to remove materials excavated from the bell footing.

(g)(1) Minimum requirements for trench timbering shall be in accordance with Table P-2.

(2) Braces and diagonal shores in a wood shoring system shall not be subjected to compressive stress in excess of values given by the following formula:

$$S = 1300 - 20L/D$$

Maximum ratio $L/D = 50$

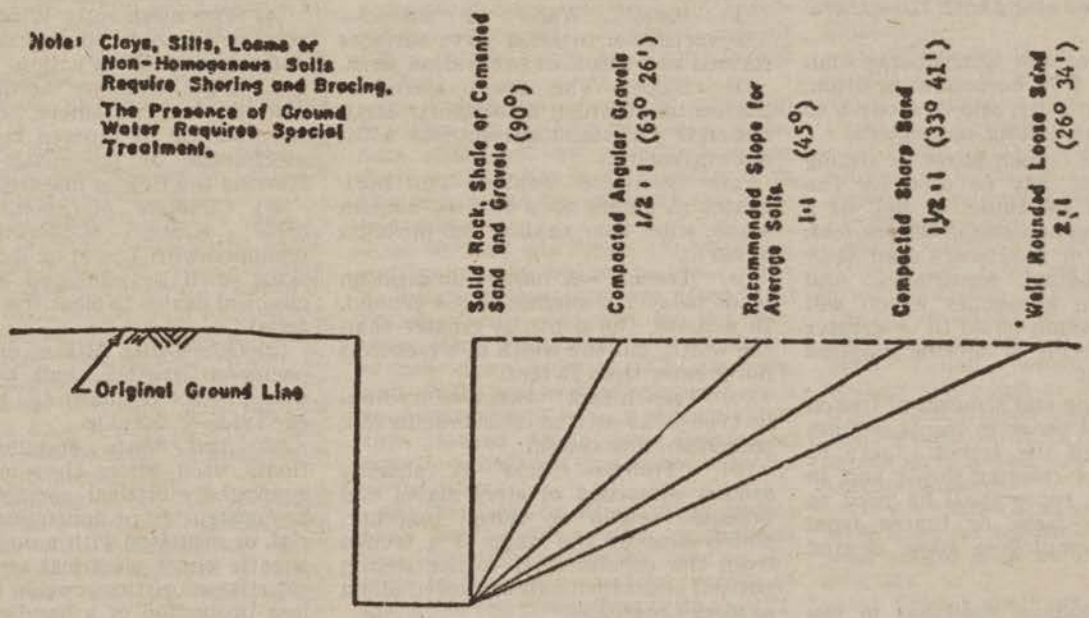
Where:

$L$ = Length, unsupported, in inches.
$D$ = Least side of the timber in inches.
$S$ = Allowable stress in pounds per square inch of cross-section.

[4510-26-C]

Table P - 1

## APPROXIMATE ANGLE OF REPOSE
### FOR SLOPING OF SIDES OF EXCAVATIONS




1926.652(g)(2)

TABLE P-2

TRENCH SHORING—MINIMUM REQUIREMENTS

| Depth of trench | Kind or condition of earth | Size and spacing of members | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Uprights | | Stringers | | Cross braces [1] | | | | Maximum spacing | | |
| | | | | | | Width of trench | | | | | | |
| | | Minimum dimension | Maximum spacing | Minimum dimension | Maximum spacing | Up to 3 feet | 3 to 6 feet | 6 to 9 feet | 9 to 12 feet | 12 to 15 feet | Vertical | Horizontal |
| Feet | | Inches | Feet | Inches | Feet | Inches | Inches | Inches | Inches | Inches | Feet | Feet |
| 5 to 10 | Hard, compact | 3 x 4 or 2 x 6 | 6 | | | 2 x 6 | 4 x 4 | 4 x 6 | 6 x 6 | 6 x 8 | 4 | 6 |
| | Likely to crack | 3 x 4 or 2 x 6 | 3 | 4 x 6 | 4 | 2 x 6 | 4 x 4 | 4 x 6 | 6 x 6 | 6 x 8 | 4 | 6 |
| | Soft, sandy, or filled | 3 x 4 or 2 x 6 | Close sheeting | 4 x 6 | 4 | 4 x 4 | 4 x 6 | 6 x 6 | 6 x 8 | 8 x 8 | 4 | 6 |
| | Hydrostatic pressure | 3 x 4 or 2 x 6 | Close sheeting | 6 x 8 | 4 | 4 x 4 | 4 x 6 | 6 x 6 | 6 x 8 | 8 x 8 | 4 | 6 |
| 10 to 15 | Hard | 3 x 4 or 2 x 6 | 4 | 4 x 6 | 4 | 4 x 4 | 4 x 6 | 6 x 6 | 6 x 8 | 8 x 8 | 4 | 6 |
| | Likely to crack | 3 x 4 or 2 x 6 | 2 | 4 x 6 | 4 | 4 x 4 | 4 x 6 | 6 x 6 | 6 x 8 | 8 x 8 | | 6 |
| | Soft, sandy, or filed | 3 x 4 or 2 x 6 | Close sheeting | 4 x 6 | 4 | 4 x 6 | 6 x 6 | 6 x 8 | 8 x 8 | 8 x 10 | 4 | 6 |
| | Hydrostatic pressure | 3 x 6 | Close sheeting | 8 x 10 | 4 | 4 x 6 | 6 x 6 | 6 x 8 | 8 x 8 | 8 x 10 | 4 | 6 |
| 15 to 20 | All kinds or conditions | 3 x 6 | Close sheeting | 4 x 12 | 4 | 4 x 12 | 6 x 8 | 8 x 8 | 8 x 10 | 10 x 10 | 4 | 6 |
| Over 20 | All kinds or conditions | 3 x 6 | Close sheeting | 6 x 8 | 4 | 4 x 12 | 8 x 8 | 8 x 10 | 10 x 10 | 10 x 12 | 4 | |

[1] Trench jacks may be used in lieu of, or in combination with, cross braces.
Shoring is not required in solid rock, hard shale, or hard slag.
Where desirable, steel sheet piling and bracing of equal strength may be substituted for wood.

[4510-26-M]

(h) When employees are required to be in trenches 4 feet deep or more, an adequate means of exit, such as a ladder or steps, shall be provided and located so as to require no more than 25 feet of lateral travel.

(i) Bracing or shoring of trenches shall be carried along with the excavation.

(j) Cross braces or trench jacks shall be placed in true horizontal position, be spaced vertically, and be secured to prevent sliding, falling, or kickouts.

(k) Portable trench boxes or sliding trench shields may be used for the protection of personnel in lieu of a shoring system or sloping. Where such trench boxes or shields are used, they shall be designed, constructed, and maintained in a manner which will provide protection equal to or greater than the sheeting or shoring required for the trench.

(l) Backfilling and removal of trench supports shall progress together from the bottom of the trench. Jacks or braces shall be released slowly and, in unstable soil, ropes shall be used to pull out the jacks or braces from above after employees have cleared the trench.

**§ 1926.653 Definitions applicable to this subpart.**

(a) "Accepted engineering requirements (or practices)"—Those requirements or practices which are compatible with standards required by a registered architect, a registered professional engineer, or other duly licensed or recognized authority.

(b) "Angle of repose"—The greatest angle above the horizontal plane at which a material will lie without sliding.

(c) "Bank"—A mass of soil rising above a digging level.

(d) "Belled excavation"—A part of a shaft or footing excavation, usually near the bottom and bell-shaped; i.e., an enlargement of the cross section above.

(e) "Braces (trench)"—The horizontal members of the shoring system whose ends bear against the uprights or stringers.

(f) "Excavation"—Any manmade cavity or depression in the earth's surface, including its sides, walls, or faces, formed by earth removal and producing unsupported earth conditions by reasons of the excavation. If installed forms or similar structures reduce the depth-to-width relationship, an excavation may become a trench.

(g) "Faces"—See paragraph (k) of this section.

(h) "Hard compact soil"—All earth materials not classified as running or unstable.

(i) "Kickouts"—Accidental release or failure of a shore or brace.

(j) "Sheet pile"—A pile, or sheeting, that may form one of a continuous interlocking line, or a row of timber, concrete, or steel piles, driven in close contact to provide a tight wall to resist the lateral pressure of water, adjacent earth, or other materials.

(k) "Sides", "Walls", or "Faces"—The vertical or inclined earth surfaces formed as a result of excavation work.

(l) "Slope"—The angle with the horizontal at which a particular earth material will stand indefinitely without movement.

(m) "Stringers" (wales)—The horizontal members of a shoring system whose sides bear against the uprights or earth.

(n) "Trench"—A narrow excavation made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench is not greater than 15 feet.

(o) "Trench jack"—Screw or hydraulic type jacks used as cross bracing in a trench shoring system.

(p) "Trench shield"—A shoring system composed of steel plates and bracing, welded or bolted together, which support the walls of a trench from the ground level to the trench bottom and which can be moved along as work progresses.

(q) "Unstable soil"—Earth material, other than running, that because of its nature or the influence of related conditions, cannot be depended upon to remain in place without extra support, such as would be furnished by a system of shoring.

(r) "Uprights"—The vertical members of a shoring system.

(s) "Wales"—See paragraph (m) of this section.

(t) "Walls"—See paragraph (k) of this section.

## Subpart Q—Concrete, Concrete Forms, and Shoring

Sec.

1926.700 General provisions.
1926.701 Forms and shoring.
1926.702 Definitions applicable to this subpart.

**§ 1926.700 General provisions.**

(a) *General.* All equipment and materials used in concrete construction and masonry work shall meet the applicable requirements for design, construction, inspection, testing, maintenance and operations as prescribed in ANSI A10.9-1970, Safety Requirements for Concrete Construction and Masonry Work.

(b) *Reinforcing steel.* (1) Employees working more than 6 feet above any adjacent working surfaces, placing and tying reinforcing steel in walls, piers, columns, etc., shall be provided with a safety belt, or equivalent device, in accordance with Subpart E of this part.

(2) Employees shall not be permitted to work above vertically protruding reinforcing steel unless it has been protected to eliminate the hazard of impalement.

(3) Guying: Reinforcing steel for walls, piers, columns, and similar vertical structures shall be guyed and supported to prevent collapse.

(4) Wire mesh rolls: Wire mesh rolls shall be secured at each end to prevent dangerous recoiling action.

(c) *Bulk concrete handling.* Bulk storage bins, containers, or silos shall have conical or tapered bottoms with mechanical or pneumatic means of starting the flow of material.

(d) *Concrete placement*—(1) *Concrete mixers.* Concrete mixers equipped with 1-yard or larger loading skips shall be equipped with a mechanical device to clear the skip of material.

(2) *Guardrails.* Mixers of 1-yard capacity or greater shall be equipped with protective guardrails installed on each side of the skip.

(3) *Bull floats.* Handles on bull floats, used where they may contact energized electrical conductors, shall be constructed of nonconductive material, or insulated with a nonconductive sheath whose electrical and mechanical characteristics provide the equivalent protection of a handle constructed of nonconductive material.

(4) *Powered concrete trowels.* Powered and rotating-type concrete troweling machines that are manually guided shall be equipped with a control switch that will automatically shut off the power whenever the operator removes his hands from the equipment handles.

(5) *Concrete buggies.* Handles of buggies shall not extend beyond the wheels on either side of the buggy. Installation of knuckle guards on buggy handles is recommended.

(6) *Pumpcrete systems.* Pumpcrete or similar systems using discharge pipes shall be provided with pipe supports designed for 100 percent overload. Compressed air hose in such systems shall be provided with positive failsafe joint connectors to prevent separation of sections when pressurized.

(7) *Concrete buckets.* (i) Concrete buckets equipped with hydraulic or pneumatically operated gates shall have positive safety latches or similar safety devices installed to prevent aggregate and loose material from accumulating on the top and sides of the bucket.

(ii) Riding of concrete buckets for any purpose shall be prohibited, and vibrator crews shall be kept out from under concrete buckets suspended from cranes or cableways.

(8) When discharging on a slope, the wheels of ready-mix trucks shall be

blocked and the brakes set to prevent movement.

(9) Nozzlemen applying a cement, sand, and water mixture through a pneumatic hose shall be required to wear protective head and face equipment, as prescribed in Subpart E of this part.

(e) *Vertical shoring*—(1) *General requirements.* (i) When temporary storage of reinforcing rods, material, or equipment on top of formwork becomes necessary, these areas shall be strengthened to meet the intended loads.

(ii) The sills for shoring shall be sound, rigid, and capable of carrying the maximum intended load.

(iii) All shoring equipment shall be inspected prior to erection to determine that it is as specified in the shoring layout. Any equipment found to be damaged shall not be used for shoring.

(iv) Erected shoring equipment shall be inspected immediately prior to, during, and immediately after the placement of concrete. Any shoring equipment that is found to be damaged or weakened shall be immediately reinforced or reshored.

(v) Reshoring shall be provided when necessary to safely support slabs and beams after stripping, or where such members are subjected to superimposed loads due to construction work done.

(2) *Tubular welded frame shoring.* (i) Metal tubular frames used for shoring shall not be loaded beyond the safe working load recommended by the manufacturer.

(ii) All locking devices on frames and braces shall be in good working order; coupling pins shall align the frame or panel legs; pivoted cross braces shall have their center pivot in place; and all components shall be in a condition similar to that of original manufacture.

(iii) When checking the erected shoring frames with the shoring layout, the spacing between towers and cross brace spacing shall not exceed that shown on the layout, and all locking devices shall be in the closed position.

(iv) Devices for attaching the external lateral stability bracing shall be securely fastened to the legs of the shoring frames.

(v) All baseplates, shore heads, extension devices, or adjustment screws shall be in firm contact with the footing sill and the form.

**§ 1926.701 Forms and shoring.**

(a) *General provisions.* (1) Formwork and shoring shall be designed, erected, supported, braced, and maintained so that it will safely support all vertical and lateral loads that may be imposed upon it during placement of concrete.

(2) Drawings or plans showing the jack layout, formwork, shoring, working decks, and scaffolding, shall be available at the jobsite.

(3) Stripped forms and shoring shall be removed and stockpiled promptly after stripping, in all areas in which persons are required to work or pass. Protruding nails, wire ties, and other form accessories not necessary to subsequent work shall be pulled, cut, or other means taken to eliminate the hazard.

(4) Imposition of any construction loads on the partially completed structure shall not be permitted unless such loading has been considered in the design and approved by the engineer-architect.

(b) *Vertical slip forms.* (1) The steel rods or pipe on which the jacks climb or by which the forms are lifted shall be specifically designed for the purpose. Such rods shall be adequately braced where not encased in concrete.

(2) Jacks and vertical supports shall be positioned in such a manner that the vertical loads are distributed equally and do not exceed the capacity of the jacks.

(3) The jacks or other lifting devices shall be provided with mechanical dogs or other automatic holding devices to provide protection in case of failure of the power supply or the lifting mechanism.

(4) Lifting shall proceed steadily and uniformly and shall not exceed the predetermined safe rate of lift.

(5) Lateral and diagonal bracing of the forms shall be provided to prevent excessive distortion of the structure during the jacking operation.

(6) During jacking operations, the form structure shall be maintained in line and plumb.

(7) All vertical lift forms shall be provided with scaffolding or work platforms completely encircling the area of placement.

(c) *Tube and coupler shoring.* (1) Couplers (clamps) shall not be used if they are deformed, broken, or have defective or missing threads on bolts, or other defects.

(2) The material used for the couplers (clamps) shall be of a structural type such as drop-forged steel, malleable iron, or structural grade aluminum. Gray cast iron shall not be used.

(3) When checking the erected shoring towers with the shoring layout, the spacing between posts shall not exceed that shown on the layout, and all interlocking of tubular members and tightness of couples shall be checked.

(4) All baseplates, shore heads, extension devices, or adjustment screws shall be in firm contact with the footing sill and the form material and shall be snug against the posts.

(d) *Single post shores.* (1) For stability, single post shores shall be horizontally braced in both the longitudinal and transverse directions, and diagonal bracing shall also be installed. Such bracing shall be installed as the shores are being erected.

(2) All baseplates or shore heads of single post shores shall be in firm contact with the footing sill and the form materials.

(3) Whenever single post shores are used in more than one tier, the layout shall be designed and inspected by a structural engineer.

(4) When formwork is at an angle, or sloping, or when the surface shored is sloping, the shoring shall be designed for such loading.

(5) Adjustment of single post shores to raise formwork shall not be made after concrete is in place.

(6) Fabricated single post shores shall not be used if heavily rusted, bent, dented, rewelded, or having broken weldments or other defects. If they contain timber, they shall not be used if timber is split, cut, has sections removed, is rotted, or otherwise structurally damaged.

(7) All timber and adjusting devices to be used for adjustable timber single post shores shall be inspected before erection.

(8) Timber shall not be used if it is split, cut, has sections removed, is rotted, or is otherwise structurally damaged.

(9) Adjusting devices shall not be used if heavily rusted, bent, dented, rewelded, or having broken weldments or other defects.

(10) All nails used to secure bracing or adjustable timber single post shores shall be driven home and the point of the nail bent over if possible.

**§ 1926.702 Definitions applicable to this subpart.**

(a) "Bull float"—A tool used to spread out and smooth the concrete.

(b) "Formwork" or "falsework"—The total system of support for freshly placed concrete, including the mold or sheathing which contacts the concrete as well as all supporting members, hardware, and necessary bracing.

(c) "Guy"—A line that steadies a high piece or structure by pulling against an off-center load.

(d) "Shore"—A supporting member that resists a compressive force imposed by a load.

(e) "Vertical slip forms"—Forms which are jacked vertically and continuously during placing of the concrete.

## Subpart R—Steel Erection

Sec.

1926.750 Flooring requirements.
1926.751 Structural steel assembly.
1926.752 Bolting, riveting, fitting-up, and plumbing-up.

**§ 1926.750 Flooring requirements.**

(a) *Permanent flooring—skeleton steel construction in tiered buildings.* (1) The permanent floors shall be installed as the erection of structural members progresses, and there shall be not more than eight stories between the erection floor and the uppermost permanent floor, except where the structural integrity is maintained as a result of the design.

(2) At no time shall there be more than four floors or 48 feet of unfinished bolting or welding above the foundation or uppermost permanently secured floor.

(b) *Temporary flooring—skeleton steel construction in tiered buildings.* (1) (i) The derrick or erection floor shall be solidly planked or decked over its entire surface except for access openings. Planking or decking of equivalent strength, shall be of proper thickness to carry the working load. Planking shall be not less than 2 inches thick full size undressed, and shall be laid tight and secured to prevent movement.

(ii) On buildings or structures not adaptable to temporary floors, and where scaffolds are not used, safety nets shall be installed and maintained whenever the potential fall distance exceeds two stories or 25 feet. The nets shall be hung with sufficient clearance to prevent contacts with the surface of structures below.

(iii) Floor periphery—safety railing. A safety railing of ½-inch wire rope or equal shall be installed, approximately 42 inches high, around the periphery of all temporary-planked or temporary metal-decked floors of tier buildings and other multifloored structures during structural steel assembly.

(2) (i) Where skeleton steel erection is being done, a tightly planked and substantial floor shall be maintained within two stories or 30 feet, whichever is less, below and directly under that portion of each tier of beams on which any work is being performed, except when gathering and stacking temporary floor planks on a lower floor, in preparation for transferring such planks for use on an upper floor. Where such a floor is not practicable, paragraph (b)(1)(ii) of this section applies.

(ii) When gathering and stacking temporary floor planks, the planks shall be removed successively, working toward the last panel of the temporary floor so that the work is always done from the planked floor.

(iii) When gathering and stacking temporary floor planks from the last panel, the employees assigned to such work shall be protected by safety belts with safety lines attached to a catenary line or other substantial anchorage.

(c) *Flooring—other construction.* (1) In the erection of a building having double wood floor construction, the rough flooring shall be completed as the building progresses, including the tier below the one on which floor joists are being installed.

(2) For single wood floor or other flooring systems, the floor immediately below the story where the floor joists are being installed shall be kept planked or decked over.

**§ 1926.751 Structural steel assembly.**

(a) During the final placing of solid web structural members, the load shall not be released from the hoisting line until the members are secured with not less than two bolts, or the equivalent at each connection and drawn up wrench tight.

(b) Open web steel joists shall not be placed on any structural steel framework unless such framework is safely bolted or welded.

(c) (1) In steel framing, where bar joists are utilized, and columns are not framed in at least two directions with structural steel members, a bar joist shall be field-bolted at columns to provide lateral stability during construction.

(2) Where longspan joists or trusses, 40 feet or longer, are used, a center row of bolted bridging shall be installed to provide lateral stability during construction prior to slacking of hoisting line.

(3) No load shall be placed on open web steel joists until these security requirements are met.

(d) Tag lines shall be used for controlling loads.

**§ 1926.752 Bolting, riveting, fitting-up, and plumbing-up.**

(a) *General requirements.* (1) Containers shall be provided for storing or carrying rivets, bolts, and drift pins, and secured against accidental displacement when aloft.

(2) Pneumatic hand tools shall be disconnected from the power source, and pressure in hose lines shall be released, before any adjustments or repairs are made.

(3) Air line hose sections shall be tied together except when quick disconnect couplers are used to join sections.

(4) Eye protection shall be provided in accordance with Subpart E of this part.

(b) *Bolting.* (1) When bolts or drift pins are being knocked out, means shall be provided to keep them from falling.

(2) Impact wrenches shall be provided with a locking device for retaining the socket.

(c) *Riveting.* (1) Riveting shall not be done in the vicinity of combustible material unless precautions are taken to prevent fire.

(2) When rivet heads are knocked off, or backed out, means shall be provided to keep them from falling.

(3) A safety wire shall be properly installed on the snap and on the handle of the pneumatic riveting hammer and shall be used at all times. The wire size shall be not less than No. 9 (B&S gauge), leaving the handle and annealed No. 14 on the snap, or equivalent.

(d) *Plumbing-up.* (1) Connections of the equipment used in plumbing-up shall be properly secured.

(2) The turnbuckles shall be secured to prevent unwinding while under stress.

(3) Plumbing-up guys related equipment shall be placed so that employees can get at the connection points.

(4) Plumbing-up guys shall be removed only under the supervision of a competent person.

(e) Wood planking shall be of proper thickness to carry the working load, but shall be not less than 2 inches thick full size undressed, exterior grade plywood, at least ¾-inch thick, or equivalent material.

(f) Metal decking of sufficient strength shall be laid tight and secured to prevent movement.

(g) Planks shall overlap the bearing on each end by a minimum of 12 inches.

(h) Wire mesh, exterior plywood, or equivalent, shall be used around columns where planks do not fit tightly.

(i) Provisions shall be made to secure temporary flooring against displacement.

(j) All unused openings in floors, temporary or permanent, shall be completely planked over or guarded in accordance with Subpart M of this part.

(k) Employees shall be provided with safety belts in accordance with § 1926.104 when they are working on float scaffolds.

## Subpart S—Tunnels and Shafts, Caissons, Cofferdams, and Compressed Air

Sec.

1926.800 Tunnels and shafts.
1926.801 Caissons.
1926.802 Cofferdams.
1926.803 Compressed air.
1926.804 Definitions applicable to this subpart.

**§ 1926.800 Tunnels and shafts.**

(a) *General.* (1) The specific requirements of this Subpart S, Tunnels, Shafts, Caissons, Cofferdams, and Compressed Air, shall be complied

with as well as the applicable provisions of all other subparts of this part.

(2) Safe means of access shall be provided and maintained to all working places.

(3) When ladders and stairways are provided in shafts and steep inclines, they shall meet the requirements of Subparts L and M of this part.

(4) Access to unattended underground openings shall be restricted by gates or doors. Unused chutes, manways, or other openings shall be tightly covered, bulkheaded, or fenced off, and posted. Conduits, trenches, and manholes shall meet the requirements of Subparts M and P of this part.

(5) Subsidence areas that present hazards shall be fenced and posted.

(6) Each operation shall have a check-in and check-out system that will provide positive identification of every employee underground. An accurate record and location of the employees shall be kept on the surface.

(b) *Emergency provisions.* (1) Evacuation plans and procedures shall be developed and made known to the employees.

(2) Emergency hoisting facilities shall be readily available at shafts more than 50 feet in depth, unless hoisting facilities are provided that are independent of electrical power failures. A boatswain's chair shall meet the requirements of Subpart L of this part.

(3) Bureau of Mines approved self-rescuers shall be available near the advancing face to equip each face employee. Such equipment shall be on the haulage equipment and in other areas where employees might be trapped by smoke or gas, and shall be maintained in good condition.

(4) Telephone or other signal communication shall be provided between the work face and the tunnel portal, and such systems shall be independent of the tunnel power supply.

(c) *Air Quality and Ventilation*—(1) *Air quality and quantity.* (i) Instruments shall be provided to test the atmosphere quantitatively for carbon monoxide, nitrogen dioxide, flammable, or toxic gases, dusts, mists, and fumes that occur in the tunnel or shaft. Tests shall be conducted as frequently as necessary to assure that the required quality and quantity of air is maintained. A record of all tests shall be maintained and be kept available.

(ii) Field-type oxygen analyzers, or other suitable devices, shall be used to test for oxygen deficiency.

(iii) Respirators shall not be substituted for environmental control measures. However, where environmental controls have not yet been developed, or when necessary by the nature of the work involved (for example, welding, sand blasting, lead burning), an employee may work for short periods of time in concentrations of airborne contaminants which exceed the limit of permissible excursions referred to in subdivisions (iv) and (v) of this subparagraph, if such employee wears a respiratory protective device approved by the Bureau of Mines as protection against the particular hazards involved.

(iv) The exposure to airborne contaminants of an employee working in a tunnel or shaft shall not exceed the threshold limit values adopted by the American Conference of Governmental Industrial Hygienists, as set forth and explained in the 1970 edition of "Threshold Limit Values of Airborne Contaminants."

(v) Employees shall be withdrawn from areas in which there is a concentration of an airborne contaminant which exceeds the threshold limit value listed for that contaminant.

(vi) Atmospheres in all active areas shall contain at least 20 percent oxygen.

(2) *Ventilation.* (i) Tunnels shall be provided with mechanically induced primary ventilation in all work areas. The direction of airflow shall be reversible.

(ii) Ventilation doors, not operated mechanically, shall be designed and installed so that they are self-closing and will remain closed regardless of the direction of the air movement.

(iii) When there has been a failure of ventilation, and ventilation has been restored in a reasonable time, all places where flammable gas may have accumulated shall be examined by a competent person and determined to be free of flammable gas before power is restored and work resumed.

(iv) When the main fan or fans have been shut down with all employees out of the adit, tunnel or shaft. no employee, other than those qualified to examine the adit, tunnel, or shaft, or other authorized employee, shall go underground until the fans have been started, the work areas examined for gas and other hazards, and declared safe.

(v) The supply of fresh air shall not be less than 200 cubic feet per minute for each employee underground. The linear velocity of the air flow in the tunnel bore shall not be less than 30 feet per minute in those tunnels where blasting or rock drilling is conducted or where there are other conditions that are likely to produce dusts, fumes, vapors, or gases in harmful quantities.

(vi) If 1.5 percent or higher concentration of flammable gas is detected in air returning from an underground working place or places, the employees shall be withdrawn and the power cut off to the portion of the area endangered by such flammable gas until the concentration of such gas is reduced to 1 percent or less.

(vii) Internal combustion engines other than mobile diesel shall not be used underground. Mobile diesel-powered equipment used underground shall be certified by the Bureau of Mines, U.S. Department of the Interior according to the Bureau of Mines publication "Mechanical Equipment for Mines—tests for permissibility and suitability, Part 32, Mobile Diesel Power Equipment for Non-Coal Mines, Schedule 24" of March 23, 1965.

(d) *Illumination.* (1) Sufficient lighting shall be provided, in accordance with the requirements of Table D–3 of Subpart D of this part, to permit safe operations at the face as well as in the general tunnel or shaft area and at the employees' workplace.

(e) *Fire prevention and control*—(1) *General.* (i) The requirements for fire prevention and protection specified in Subpart F of this part shall be complied with in all tunnel and shaft operations.

(ii) Signs warning against smoking and open flames shall be posted so that they can be readily seen in areas or places where fire or explosion hazards exist.

(iii) The carrying of matches, lighters, or other flame-producing smoking materials shall be prohibited in all underground operations where fire or explosion hazards exist.

(iv) Not more than a 1 day's supply of diesel fuel shall be stored underground.

(v) Gasoline or liquefied petroleum gases shall not be taken, stored, or used underground.

(vi) Oil, grease, or fuel stored underground shall be kept in tightly sealed containers in fire-resistant areas, at safe distances from explosives magazines, electrical installations, and shaft stations.

(vii) Air that has passed through underground oil or fuel-storage areas shall not be used to ventilate working areas.

(viii) Approved fire-resistant hydraulic fluids shall be used in hydraulically actuated underground machinery and equipment.

(ix) Fires shall not be built underground.

(x) Noncombustible barriers shall be installed below welding or burning operations in or over a shaft or raise.

(xi) Fire extinguishers or equivalent protection shall be provided at the head and tail pulleys of underground belt conveyors and at 300-foot intervals along the belt line.

(xii) At tunnel operations, employing 25 or more employees at one time underground at least two rescue crews (10 employees divided between shifts) shall be trained annually in rescue procedures, in the use, care, and limi-

tations of oxygen breathing apparatus, and the use and maintenance of firefighting equipment. Not less than one crew (5 employees) shall be trained at smaller operations.

(f) *Personal protective equipment.* Protective clothing or equipment shall be worn as specified in Subparts D and E of this part.

(g) *Noise.* (1) Permissible noise exposures shall conform to those specified in Subpart D of this part.

(h) *Ground support*—(1) *Tunnel portal area.* Portals shall be protected and supported where loose soil or rock or fractured material is encountered.

(2) *Tunnel area.* (i) The employer shall examine and test the roof, face, and walls of the work area at the start of each shift, and frequently thereafter.

(ii) Loose ground shall be taken down or supported. Ground conditions along haulage ways and travelways shall be examined periodically and scaled or supported as necessary.

(iii) Torque meters and torque wrenches shall be available at tunnels where rock bolts are used for ground support. Frequent tests shall be made to determine if bolts meet the required torque. The test frequency shall be determined by rock conditions and distance from vibration sources.

(iv) Damaged or dislodged tunnel supports, whether steel sets or timber, shall be repaired or replaced. New supports shall be installed whenever possible before removing the damaged supports.

(v) All sets, including horseshoe-shaped or arched rib steel sets, shall be designed and installed so that the bottoms will have required anchorage to prevent pressures from pushing them inward into the excavation. Lateral bracing shall be provided between sets to further stabilize the support.

(3) *Shafts.* (i) Small diameter shafts, which employees are required to enter, shall be provided with a steel casing, concrete pipe, timber, or other material of required strength to support the surrounding earth.

(ii) The casing and bracing shall be provided the full depth of the shaft, or at least 5 feet into solid rock if possible, and shall extend at least 1 foot above ground level.

(iii) All wells or shafts over 5 feet in depth shall be retained with lagging, spiling, or casing.

(iv) In shafts, the employer shall inspect the walls, ladders, timbers, blocking, and wedges of the last set to determine if they have loosened following blasting operations. Where found unsafe, corrections shall be made before shift operations are started.

(v) Safety belts shall be worn on skips and platforms used in shafts by crews when the skip or cage does not occlude the opening to within 1 foot of the sides of the shaft, unless guardrails or cages are provided.

(i) *Drilling.* (1) Equipment that is to be used during a shift shall be inspected each shift by a competent person. Equipment defects affecting safety shall be corrected before the equipment is used.

(2) The drilling area shall be inspected for hazards before starting the drilling operation.

(3) Employees shall not be allowed on a drill mast while the drill bit is in operation.

(4) When a drill is being moved from one drilling area to another, drill steel, tools, and other equipment shall be secured, and the mast placed in a safe position.

(5) Receptacles or racks shall be provided for drill steel stored on jumbos.

(6) Before drilling cycle is started, warning shall be given to men working below jumbo decks.

(7) Drills on columns shall be anchored firmly before drilling is started and shall be retightened frequently thereafter.

(8) The employer shall provide mechanical means for lifting drills, roof bolts, mine straps, and other unwieldy heavy material to the top decks of jumbos over 10 feet in height.

(9) The employer shall provide stair access to jumbo decks wide enough to accommodate two persons if the deck is over 10 feet in height.

(10) On jumbo decks over 10 feet in height, guardrails which are removable (pipe in sockets with chain handrail), or equal, shall be provided on all sides and back platforms.

(11) Scaling bars shall be in good condition at all times, and blunted and severely worn bars shall not be used.

(12) When jumbos are being removed, riders will not be allowed on the jumbo unless they are assisting the driver.

(13) Before commencing the drill cycle, the face and lifters shall be examined for misfires (residual explosives) and, if found, they shall be removed before drilling commences at the face. Lifters shall not be drilled through blasted rock (muck) or water.

(14) Air lines that are buried in the invert shall be identified by signs posted nearby, warning all personnel.

(j) *Blasting.* All blasting and explosives-handling operations shall be conducted in compliance with Subpart U of this part.

(k) *Haulage.* (1) Equipment that is to be used during a shift shall be inspected by a competent person each shift. Equipment defects affecting safety shall be corrected before the equipment is used.

(2) Powered mobile equipment shall be provided with adequate brakes.

(3) Powered mobile haulage equipment shall be provided with audible warning devices. Lights shall be provided at both ends.

(4) Cab windows shall be of safety glass, or equivalent, in good condition, and shall be kept clean.

(5) Adequate backstops or brakes shall be installed on inclined conveyor drive units to prevent conveyors from running in reverse and creating a hazard to employees.

(6) No employees shall be permitted to ride a power-driven chain, belt, or bucket conveyor, unless the conveyor is specifically designed for the transportation of employees.

(7) The employer shall not permit employees to ride in dippers, shovel buckets, forks, clamshells, or in the beds of dump trucks, or on haulage equipment not specifically designed or adapted for the transportation of employees.

(8) Electrically powered mobile equipment shall not be left unattended unless the master switch is in the off position, all operating controls are in the neutral position, and the brakes are set, or other equivalent precautions are taken against rolling.

(9) When dumping cars by hand, the car dumps shall be provided with tie-down chains or bumper blocks to prevent cars from overturning.

(10) Rocker-bottom or bottom-dump cars shall be equipped with positive locking devices.

(11) Equipment which is to be hauled shall be so loaded and protected as to prevent sliding or spillage.

(12) Parked railcars shall be blocked securely.

(13) Berms, bumper blocks, safety hooks, or similar means shall be provided to prevent overtravel and overturning at dumping locations.

(14) Where necessary, bumper blocks, or the equivalent, shall be provided at all track dead ends.

(15) Supplies, materials, and tools, other than small handtools, shall not be transported with employees in mantrip cars.

(l) *Electrical equipment.* (1) Electrical equipment shall conform to the requirements of Subpart K of this part.

(2) Powerlines shall be well separated or insulated from water lines, telephone lines, and air lines.

(3) Oil-filled transformers shall not be used underground unless they are located in a fire-resistant enclosure and surrounded by a dike to contain the contents of the transformers in event of a rupture.

(m) *Hoisting.* (1) Hoisting machines, either powered or hand operated, shall be worm-geared or powered both ways. The design must be such that when the power is stopped, the load cannot move.

(2) Controls for powered hoists shall be of the deadman type with a non-locking switch or control.

(3) A device to shut off the power shall be installed ahead of the operating control.

(4) Hand-operated release mechanisms, which can permit the load to descend faster than the speed rating, shall not be used.

(5) Hoist machines with cast metal parts shall not be used.

(6) Every hoist shall be tested with twice the maximum load before being put into operation, and annually thereafter.

(7) All anchorages of hoists shall be inspected at the beginning of each shift.

(8) An enclosed covered metal cage shall be used to raise and lower persons in the shaft. The cage shall be designed with a safety factor of 4 and shall be load-tested prior to use. The exterior of the cage shall be free of projections or sharp corners. Only closed shackles shall be used in the cage rigging.

(9) If the cage is equipped with a door, a positive locking device shall be installed to prevent the door from opening accidentally while the cage is being lowered or raised while hoisting or lowering employees.

**§ 1926.801 Caissons.**

(a) Wherever, in caisson work in which compressed air is used, and the working chamber is less than 11 feet in length, and when such caissons are at any time suspended or hung while work is in progress so that the bottom of the excavation is more than 9 feet below the deck of the working chamber, a shield shall be erected therein for the protection of the employees.

(b) Shafts shall be subjected to a hydrostatic or air-pressure test, at which pressure they shall be tight. The shaft shall be stamped on the outside shell about 12 inches from each flange to show the pressure to which they have been subjected.

(c) Whenever a shaft is used, it shall be provided, where space permits, with a safe, proper, and suitable staircase for its entire length, including landing platforms, not more than 20 feet apart. Where this is impracticable, suitable ladders shall be installed with landing platforms located about 20 feet apart to break the climb.

(d) All caissons having a diameter or side greater than 10 feet shall be provided with a man lock and shaft for the exclusive use of employees.

(e) In addition to the gauge in the locks, an accurate gauge shall be maintained on the outer and inner side of each bulkhead. These gauges shall be accessible at all times and kept in accurate working order.

(f) In caisson operations where employees are exposed to compressed air working environments, the requirements contained in § 1926.803 shall be complied with.

**§ 1926.802 Cofferdams.**

(a) If overtopping of the cofferdam by high waters is possible, means shall be provided for controlled flooding of the work area.

(b) Warning signals for evacuation of employees in case of emergency shall be developed and posted.

(c) Cofferdam walkways, bridges, or ramps with at least two means of rapid exit shall be provided with guardrails as specified in Subpart M of this part.

(d) Cofferdams located close to navigable shipping channels shall be protected from vessels in transit, where possible.

**§ 1926.803 Compressed air.**

(a) *General provisions.* (1) There shall be present, at all times, at least one competent person designated by and representing the employer, who shall be familiar with this subpart in all respects, and responsible for full compliance with these and other applicable subparts.

(2) Every employee shall be instructed in the rules and regulations which concern his safety or the safety of others.

(b) *Medical attendance, examination, and regulations.* (1) There shall be retained one or more licensed physicians familiar with and experienced in the physical requirements and the medical aspects of compressed air work and the treatment of decompression illness. He shall be available at all times while work is in progress in order to provide medical supervision of employees employed in compressed air work. He shall himself be physically qualified and be willing to enter a pressurized environment.

(2) No employee shall be permitted to enter a compressed air environment until he has been examined by the physician and reported by him to be physically qualified to engage in such work.

(3) In the event an employee is absent from work for 10 days, or is absent due to sickness or injury, he shall not resume work until he is reexamined by the physician, and his physical condition reported, as provided in this paragraph, to be such as to permit him to work in compressed air.

(4) After an employee has been employed continuously in compressed air for a period designated by the physician, but not to exceed 1 year, he shall be reexamined by the physician to determine if he is still physically qualified to engage in compressed air work.

(5) Such physician shall at all times keep a complete and full record of examinations made by him. The physician shall also keep an accurate record of any decompression illness or other illness or injury incapacitating any employee for work, and of all loss of life that occurs in the operation of a tunnel, caisson, or other compartment in which compressed air is used.

(6) Records shall be available for the inspection of the Secretary or his representatives, and a copy thereof shall be forwarded to OSHA within 48 hours following the occurrence of the accident, death, injury, or decompression illness. It shall state as fully as possible the cause of said death or decompression illness, and the place where the injured or sick employee was taken, and such other relative information as may be required by the Secretary.

(7) A fully equipped first aid station shall be provided at each tunnel project regardless of the number of persons employed. An ambulance or transportation suitable for a litter case shall be at each project.

(8) Where tunnels are being excavated from portals more than 5 road miles apart, a first aid station and transportation facilities shall be provided at each portal.

(9) A medical lock shall be established and maintained in immediate working order whenever air pressure in the working chamber is increased above the normal atmosphere.

(10) The medical lock shall:

(i) Have at least 6 feet of clear headroom at the center, and be subdivided into not less than two compartments;

(ii) Be readily accessible to employees working under compressed air;

(iii) Be kept ready for immediate use for at least 5 hours subsequent to the emergence of any employee from the working chamber;

(iv) Be properly heated, lighted and ventilated;

(v) Be maintained in a sanitary condition;

(vi) Have a nonshatterable port through which the occupant(s) may be kept under constant observation;

(vii) Be designed for a working pressure of 75 p.s.i.g.;

(viii) Be equipped with internal controls which may be overridden by external controls;

(ix) Be provided with air pressure gauges to show the air pressure within each compartment to observers inside and outside the medical lock;

(x) Be equipped with a manual type sprinkler system that can be activated inside the lock or by the outside lock tender;

(xi) Be provided with oxygen lines and fittings leading into external tanks. The lines shall be fitted with check valves to prevent reverse flow.

The oxygen system inside the chamber shall be of a closed circuit design and be so designed as to automatically shut off the oxygen supply whenever the fire system is activated;

(xii) Be in constant charge of an attendant under the direct control of the retained physician. The attendant shall be trained in the use of the lock and suitably instructed regarding steps to be taken in the treatment of employee exhibiting symptoms compatible with a diagnosis of decompression illness;

(xiii) Be adjacent to an adequate emergency medical facility;

(xiv) The medical facility shall be equipped with demand-type oxygen inhalation equipment approved by the U.S. Bureau of Mines;

(xv) Be capable of being maintained at a temperature, in use, not to exceed 90° F. nor be less than 70° F.; and

(xvi) Be provided with sources of air, free of oil and carbon monoxide, for normal and emergency use, which are capable of raising the air pressure in the lock from 0 to 75 p.s.i.g. in 5 minutes.

(11) Identification badges shall be furnished to all employees, indicating that the wearer is a compressed air worker. A permanent record shall be kept of all identification badges issued. The badge shall give the employee's name, address of the medical lock, the telephone number of the licensed physician for the compressed air project, and contain instructions that in case of emergency of unknown or doubtful cause or illness, the wearer shall be rushed to the medical lock. The badge shall be worn at all times—off the job, as well as on the job.

(c) *Telephone and signal communication.* (1) Effective and reliable means of communication, such as bells, whistles, or telephones, shall be maintained, at all times between all the following locations:

(i) The working chamber face;

(ii) The working chamber side of the man lock near the door;

(iii) The interior of the man lock;

(iv) Lock attendant's station;

(v) The compressor plant;

(vi) The first-aid station;

(vii) The emergency lock (if one is required); and

(viii) The special decompression chamber (if one is required).

(d) *Signs and records.* (1) The time of decompression shall be posted in each man lock as follows:

TIME OF DECOMPRESSION FOR THIS LOCK

——— pounds to ——— pounds in ———minutes.
——— pounds to ——— pounds in ——— minutes.
(Signed by) ——————(Superintendent)

This form shall be posted in the Man Lock at all times.

(2) Any code of signals used shall be conspicuously posted near workplace entrances and such other locations as may be necessary to bring them to the attention of all employees concerned.

(3) For each 8-hour shift, a record of employees employed under air pressure shall be kept by an employee who shall remain outside the lock near the entrance. This record shall show the period each employee spends in the air chamber and the time taken from decompression. A copy shall be submitted to the appointed physician after each shift.

(e) *Compression.* (1) Every employee going under air pressure for the first time shall be instructed on how to avoid excessive discomfort.

(2) During the compression of employees, the pressure shall not be increased to more than 3 p.s.i.g. within the first minute. The pressure shall be held at 3 p.s.i.g. and again at 7 p.s.i.g. sufficiently long to determine if any employees are experiencing discomfort.

(3) After the first minute the pressure shall be raised uniformly and at a rate not to exceed 10 p.s.i. per minute.

(4) If any employee complains of discomfort, the pressure shall be held to determine if the symptoms are relieved. If, after 5 minutes the discomfort does not disappear, the lock attendant shall gradually reduce the pressure until the employee signals that the discomfort has ceased. If he does not indicate that the discomfort has disappeared, the lock attendant shall reduce the pressure to atmospheric and the employee shall be released from the lock.

(5) No employee shall be subjected to pressure exceeding 50 pounds per square inch except in emergency.

(f) *Decompression.* (1) Decompression to normal condition shall be in accordance with the Decompression Tables in Exhibit A of this subpart.

(2) In the event it is necessary for an employee to be in compressed air more than once in a 24-hour period, the appointed physician shall be responsible for the establishment of methods and procedures of decompression applicable to repetitive exposures.

(3) If decanting is necessary, the appointed physician shall establish procedures before any employee is permitted to be decompressed by decanting methods. The period of time that the employees spend at atmospheric pressure between the decompression following the shift and recompression shall not exceed 5 minutes.

(g) *Man locks and special decompression chambers*—(1) *Man locks.* (i) Except in emergency, no employees employed in compressed air shall be permitted to pass from the working chamber to atmospheric pressure until after decompression, in accordance with the procedures in this subpart.

(ii) The lock attendant in charge of a man lock shall be under the direct supervision of the appointed physician. He shall be stationed at the lock controls on the free air side during the period of compression and decompression and shall remain at the lock control station whenever there are men in the working chamber or in the man lock.

(iii) Except where air pressure in the working chamber is below 12 p.s.i.g., each man lock shall be equipped with automatic controls which, through taped programs, cams, or similar apparatus, shall automatically regulate decompressions. It shall also be equipped with manual controls to permit the lock attendant to override the automatic mechanism in the event of an emergency, as provided in subdivision (viii) of this subparagraph.

(iv) A manual control, which can be used in the event of an emergency, shall be placed inside the man lock.

(v) A clock, thermometer, and continuous recording pressure gauge with a 4-hour graph shall be installed outside of each man lock and shall be changed prior to each shift's decompression. The chart shall be of sufficient size to register a legible record of variations in pressure within the man lock and shall be visible to the lock attendant. A copy of each graph shall be submitted to the appointed physician after each shift. In addition, a pressure gauge, clock, and thermometer shall also be installed in each man lock. Additional fittings shall be provided so that test gauges may be attached whenever necessary.

(vi) Except where air pressure is below 12 p.s.i.g. and there is no danger of rapid flooding, all caissons having a working area greater than 150 square feet, and each bulkhead in tunnels of 14 feet or more in diameter, or equivalent area, shall have at least two locks in perfect working condition, one of which shall be used exclusively as a man lock, the other, as a materials lock.

(vii) Where only a combination man-and-materials lock is required, this single lock shall be of sufficient capacity to hold the employees constituting two successive shifts.

(viii) Emergency locks shall be large enough to hold an entire heading shift and a limit maintained of 12 p.s.i.g. There shall be a chamber available for oxygen decompression therapy to 28 p.s.i.g.

(ix) The man lock shall be large enough so that those using it are not compelled to be in a cramped position, and shall not have less than 5 feet clear head room at the center and a

minimum of 30 cubic feet of air space per occupant.

(x) Locks on caissons shall be so located that the bottom door shall be not less than 3 feet above the water level surrounding the caisson on the outside. (The water level, where it is affected by tides, is construed to mean high tide.)

(xi) In addition to the pressure gauge in the locks, an accurate pressure gauge shall be maintained on the outer and inner side of each bulkhead. These gauges shall be accessible at all times and shall be kept in accurate working order.

(xii) Man locks shall have an observation port at least 4 inches in diameter located in such a position that all occupants of the man lock may be observed from the working chamber and from the free air side of the lock.

(xiii) Adequate ventilation in the lock shall be provided.

(xiv) Man locks shall be maintained at a minimum temperature of 70° F.

(xv) When locks are not in use and employees are in the working chamber, lock doors shall be kept open to the working chamber, where practicable.

(xvi) Provision shall be made to allow for rescue parties to enter the tunnel if the working force is disabled.

(xvii) A special decompression chamber of sufficient size to accommodate the entire force of employees being decompressed at the end of a shift shall be provided whenever the regularly established working period requires a total time of decompression exceeding 75 minutes.

(2) *Special decompression chamber.* (i) The headroom in the special decompression chamber shall be not less than a minimum 7 feet and the cubical content shall provide at least 50 cubic feet of airspace for each employee. For each occupant, there shall be provided 4 square feet of free walking area and 3 square feet of seating space, exclusive of area required for lavatory and toilet facilities. The rated capacity shall be based on the stated minimum space per employee and shall be posted at the chamber entrance. The posted capacity shall not be exceeded, except in case of emergency.

(ii) Each special decompression chamber shall be equipped with the following:

(*a*) A clock or clocks suitably placed so that the attendant and the chamber occupants can readily ascertain the time;

(*b*) Pressure gauges which will indicate to the attendants and to the chamber occupants the pressure in the chamber;

(*c*) Valves to enable the attendant to control the supply and discharge of compressed air into and from the chamber;

(*d*) Valves and pipes, in connection with the air supply and exhaust, arranged so that the chamber pressure can be controlled from within and without;

(*e*) Effective means of oral intercommunication between the attendant, occupants of the chamber, and the air compressor plant; and

(*f*) An observation port at the entrance to permit observation of the chamber occupants.

(iii) Seating facilities in special decompression chambers shall be so arranged as to permit a normal sitting posture without cramping. Seating space, not less than 18 inches by 24 inches wide, shall be provided per occupant.

(iv) Adequate toilet and washing facilities, in a screened or enclosed recess, shall be provided. Toilet bowls shall have a built-in protector on the rim so that an air space is created when the seat lid is closed.

(v) Fresh and pure drinking water shall be available. This may be accomplished by either piping water into the special decompression chamber and providing drinking fountains, or by providing individual canteens, or by some other sanitary means. Community drinking vessels are prohibited.

(vi) No refuse or discarded material of any kind shall be permitted to accumulate, and the chamber shall be kept clean.

(vii) Unless the special decompression chamber is serving as the man lock to atmospheric pressure, the special decompression chamber shall be situated, where practicable, adjacent to the man lock on the atmospheric pressure side of the bulkhead. A passageway shall be provided, connecting the special chamber with the man lock, to permit employees in the process of decompression to move from the man lock to the special chamber without a reduction in the ambient pressure from that designated for the next stage of decompression. The passageway shall be so arranged as to not interfere with the normal operation of the man lock, nor with the release of the occupants of the special chamber to atmospheric pressure upon the completion of the decompression procedure.

(h) *Compressor plant and air supply.* (1) At all times there shall be a thoroughly experienced, competent, and reliable person on duty at the air control valves as a gauge tender who shall regulate the pressure in the working areas. During tunneling operations, one gauge tender may regulate the pressure in not more than two headings: *Provided,* That the gauge and controls are all in one location. In caisson work, there shall be a gauge tender for each caisson.

(2) The low air compressor plant shall be of sufficient capacity to not only permit the work to be done safely, but shall also provide a margin to meet emergencies and repairs.

(3) Low air compressor units shall have at least two independent and separate sources of power supply and each shall be capable of operating the entire low air plant and its accessory systems.

(4) The capacity, arrangement, and number of compressors shall be sufficient to maintain the necessary pressure without overloading the equipment and to assure maintenance of such pressure in the working chamber during periods of breakdown, repair, or emergency.

(5) Switching from one independent source of power supply to the other shall be done periodically to ensure the workability of the apparatus in an emergency.

(6) Duplicate low-pressure air feedlines and regulating valves shall be provided between the source of air supply and a point beyond the locks with one of the lines extending to within 100 feet of the working face.

(7) All high- and low-pressure air supply lines shall be equipped with check valves.

(8) Low-pressure air shall be regulated automatically. In addition, manually operated valves shall be provided for emergency conditions.

(9) The air intakes for all air compressors shall be located at a place where fumes, exhaust gases, and other air contaminants will be at a minimum.

(10) Gauges indicating the pressure in the working chamber shall be installed in the compressor building, the lock attendant's station, and at the employer's field office.

(i) *Ventilation and air quality.* (1) Exhaust valves and exhaust pipes shall be provided and operated so that the working chamber shall be well ventilated, and there shall be no pockets of dead air. Outlets may be required at intermediate points along the main low-pressure air supply line to the heading to eliminate such pockets of dead air. Ventilating air shall be not less than 30 cubic feet per minute.

(2) The air in the workplace shall be analyzed by the employer not less than once each shift, and records of such tests shall be kept on file at the place where the work is in progress. The test results shall be within the threshold limit values specified in Subpart D of this part, for hazardous gases, and within 10 percent of the lower explosive limit of flammable gases. If these limits are not met, immediate action to correct the situation shall be taken by the employer.

(3) The temperature of all working chambers which are subjected to air pressure shall, by means of after-coolers or other suitable devices, be maintained at a temperature not to exceed 85° F.

(4) Forced ventilation shall be provided during decompression. During the entire decompression period, forced ventilation through chemical or mechanical air purifying devices that will ensure a source of fresh air shall be provided.

(5) Whenever heat-producing machines (moles, shields) are used in compressed air tunnel operations, a positive means of removing the heat build-up at the heading shall be provided.

(j) *Electricity.* (1) All lighting in compressed-air chambers shall be by electricity exclusively, and two independent electric-lighting systems with independent sources of supply shall be used. The emergency source shall be arranged to become automatically operative in the event of failure of the regularly used source.

(2) The minimum intensity of light on any walkway, ladder, stairway, or working level shall be not less than 10 foot-candles, and in all workplaces the lighting shall at all times be such as to enable employees to see clearly.

(3) All electrical equipment, and wiring for light and power circuits, shall comply with requirements of the National Electrical Code, ANSI C1-1971 (Rev. of 1968) for use in damp, hazardous, high temperature, and compressed air environments.

(4) External parts of lighting fixtures and all other electrical equipment, when within 8 feet of the floor, shall be constructed of noncombustible, nonabsorptive, insulating materials, except that metal may be used if it is effectively grounded.

(5) Portable lamps shall be equipped with noncombustible, nonabsorptive, insulating sockets, approved handles, basket guards, and approved cords.

(6) The use of worn or defective portable and pendant conductors is prohibited.

(k) *Sanitation.* (1) Sanitary, heated, lighted, and ventilated dressing rooms and drying rooms shall be provided for all employees engaged in compressed air work. Such rooms shall contain suitable benches and lockers. Bathing accommodations (showers at the ratio of one to 10 employees per shift), equipped with running hot and cold water, and suitable and adequate toilet accommodations, shall be provided. One toilet for each 15 employees, or fractional part thereof, shall be provided.

(2) When the toilet bowl is shut by a cover, there should be an air space so that the bowl or bucket does not implode when pressure is increased.

(3) All parts of caissons and other working compartments shall be kept in a sanitary condition.

(l) *Fire prevention and protection.* (1) Firefighting equipment shall be available at all times and shall be maintained in working condition.

(2) While welding or flame-cutting is being done in compressed air, a firewatch with a fire hose or approved extinguisher shall stand by until such operation is completed.

(3) Shafts and caissons containing flammable material of any kind, either above or below ground, shall be provided with a waterline and a fire hose connected thereto, so arranged that all points of the shaft or caisson are within reach of the hose stream.

(4) Fire hose shall be at least 1½ inches in nominal diameter; the water pressure shall at all times be adequate for efficient operation of the type of nozzle used; and the water supply shall be such as to ensure an uninterrupted flow. Fire hose, when not in use, shall be located or guarded to prevent injury thereto.

(5) The power house, compressor house, and all buildings housing ventilating equipment, shall be provided with at least one hose connection in the water line, with a fire hose connected thereto. A fire hose shall be maintained within reach of structures of wood over or near shafts.

(6) Tunnels shall be provided with a 2-inch minimum diameter water line extending into the working chamber and to within 100 feet of the working face. Such line shall have hose outlets with 100 feet of fire hose attached and maintained as follows: One at the working face; one immediately inside of the bulkhead of the working chamber; and one immediately outside such bulkhead. In addition, hose outlets shall be provided at 200-foot intervals throughout the length of the tunnel, and 100 feet of fire hose shall be attached to the outlet nearest to any location where flammable material is being kept or stored or where any flame is being used.

(7) In addition to fire hose protection required by this subpart, on every floor of every building not under compressed air, but used in connection with the compressed air work, there shall be provided at least one approved fire extinguisher of the proper type for the hazard involved. At least two approved fire extinguishers shall be provided in the working chamber as follows: One at the working face and one immediately inside the bulkhead (pressure side). Extinguishers in the working chamber shall use water as the primary extinguishing agent and shall not use any extinguishing agent which could be harmful to the employees in the working chamber. The fire extinguisher shall be protected from damage.

(8) Highly combustible materials shall not be used or stored in the working chamber. Wood, paper, and similar combustible material shall not be used in the working chamber in quantities which could cause a fire hazard. The compressor building shall be constructed of non-combustible material.

(9) Man locks shall be equipped with a manual type fire extinguisher system that can be activated inside the man lock and also by the outside lock attendant. In addition, a fire hose and portable fire extinguisher shall be provided inside and outside the man lock. The portable fire extinguisher shall be the dry chemical type.

(10) Equipment, fixtures, and furniture in man locks and special decompression chambers shall be constructed of noncombustible materials. Bedding, etc., shall be chemically treated so as to be fire resistant.

(11) Head frames shall be constructed of structural steel or open framework fireproofed timber. Head houses and other temporary surface buildings or structures within 100 feet of the shaft, caisson, or tunnel opening shall be built of fire-resistant materials.

(12) No oil, gasoline, or other combustible material shall be stored within 100 feet of any shaft, caisson, or tunnel opening, except that oils may be stored in suitable tanks in isolated fireproof buildings, provided such buildings are not less than 50 feet from any shaft, caisson, or tunnel opening, or any building directly connected thereto.

(13) Positive means shall be taken to prevent leaking flammable liquids from flowing into the areas specifically mentioned in the preceding paragraph.

(14) All explosives used in connection with compressed air work shall be selected, stored, transported, and used as specified in Subpart U of this part.

(m) *Bulkheads and safety screens.* (1) Intermediate bulkheads with locks, or intermediate safety screens or both, are required where there is the danger of rapid flooding.

(2) In tunnels 16 feet or more in diameter, hanging walkways shall be provided from the face to the man lock as high in the tunnel as practicable, with at least 6 feet of head room. Walkways shall be constructed of noncombustible material. Standard railings shall be securely installed throughout the length of all walkways on open sides in accordance with Subpart M of this part. Where walkways are ramped under safety screens, the walkway surface shall be skidproofed by cleats or by equivalent means.

(3) Bulkheads used to contain compressed air shall be tested, where prac-

ticable, to prove their ability to resist the highest air pressure which may be expected to be used.

**§ 1926.804 Definitions applicable to this subpart.**

(a) "Bulkhead"—An airtight structure separating the working chamber from free air or from another chamber under a lesser pressure than the working pressure.

(b) "Caisson"—A wood, steel, concrete or reinforced concrete, air- and water-tight chamber in which it is possible for men to work under air pressure greater than atmospheric pressure to excavate material below water level.

(c) "Decanting"—A method used for decompressing under emergency circumstances. In this procedure, the employees are brought to atmospheric pressure with a very high gas tension in the tissues and then immediately recompressed in a second and separate chamber or lock.

(d) "Emergency locks"—A lock designed to hold and permit the quick passage of an entire shift of employees.

(e) "High air"—Air pressure used to supply power to pneumatic tools and devices.

(f) "Low air"—Air supplied to pressurize working chambers and locks.

(g) "Man lock"—A chamber through which men pass from one air pressure environment into another.

(h) "Materials lock"—A chamber through which materials and equipment pass from one air pressure environment into another.

(i) "Medical lock"—A special chamber in which employees are treated for decompression illness. It may also be used in preemployment physical examinations to determine the adaptability of the prospective employee to changes in pressure.

(j) "Normal condition"—One during which exposure to compressed air is limited to a single continuous working period followed by a single decompression in any given 24-hour period; the total time of exposure to compressed air during the single continuous working period is not interrupted by exposure to normal atmospheric pressure, and a second exposure to compressed air does not occur until at least 12 consecutive hours of exposure to normal atmospheric pressure has elapsed since the employee has been under pressure.

(k) "Pressure"—A force acting on a unit area. Usually shown as pounds per square inch. (p.s.i.)

(l) "Absolute pressure" (p.s.i.a.)—The sum of the atmospheric pressure and gauge pressure (p.s.i.g.).

(m) "Atmospheric pressure"—The pressure of air at sea level, usually 14.7 p.s.i.a. (1 atmosphere), or 0 p.s.i.g.

(n) "Gauge pressure" (p.s.i.g.)—Pressure measured by a gauge and indicating the pressure exceeding atmospheric.

(o) "Safety screen"—An air- and water-tight diaphragm placed across the upper part of a compressed air tunnel between the face and bulkhead, in order to prevent flooding the crown of the tunnel between the safety screen and the bulkhead, thus providing a safe means of refuge and exit from a flooding or flooded tunnel.

(p) "Special decompression chamber"—A chamber to provide greater comfort of employees when the total decompression time exceeds 75 minutes.

(q) "Working chamber"—The space or compartment under air pressure in which the work is being done.

EXHIBIT A—DECOMPRESSION TABLES

1. *Explanation.* The decompression tables are computed for working chamber pressures from 0 to 14 pounds, and from 14 to 50 pounds per square inch gauge inclusive by 2-pound increments and for exposure times for each pressure extending from one-half to over 8 hours inclusive. Decompressions will be conducted by two or more stages with a maximum of four stages, the latter for a working chamber pressure of 40 pounds per square inch gauge or over.

Stage 1 consists of a reduction in ambient pressure ranging from 10 to a maximum of 16 pounds per square inch, but in no instance will the pressure be reduced below 4 pounds at the end of stage 1. This reduction in pressure in stage 1 will always take place at a rate not greater than 5 pounds per minute.

Further reduction in pressure will take place during stage 2 and subsequent stages as required at a slower rate, but in no event at a rate greater than 1 pound per minute.

Decompression Table No. 1 indicates in the body of the table the total decompression time in minutes for various combinations of working chamber pressure and exposure time.

Decompression Table No. 2 indicates for the same various combinations of working chamber pressure and exposure time the following:

a. The number of stages required;

b. The reduction in pressure and the terminal pressure for each required stage;

c. The time in minutes through which the reduction in pressure is accomplished for each required stage;

d. The pressure reduction rate in minutes per pound for each required stage;

IMPORTANT NOTE: The Pressure Reduction in Each Stage is Accomplished at a Uniform Rate. Do Not Interpolate Between Values Shown on the Tables. Use the Next Higher Value of Working Chamber Pressure or Exposure Time Should the Actual Working Chamber Pressure or the Actual Exposure Time, Respectively, Fall Between Those for Which Calculated Values Are Shown in the Body of the Tables.

| Examples: | Minutes |
|---|---|
| Example No. 1: | |
| 4 hours working period at 20 pounds gauge. | |
| Decompression Table No. 1: | |
| 20 pounds for 4 hours, total decompression time. | 43 |
| Decompression Table No. 2: | |
| Stage 1: Reduce pressure from 20 pounds to 4 pounds at the uniform rate of 5 pounds per minute. | |
| Elapsed time stage 1: 16/5 | 3 |
| Stage 2 (final stage): Reduce pressure at a uniform rate from 4 pounds to 0-pound gage over a period of 40 minutes. | |
| Rate—0.10 pound per minute or 10 minutes per pound. | |
| Stage 2 (final) elapsed time. | 40 |
| Total time | 43 |
| Example No. 2: | |
| 5-hour working period at 24 pounds gage. | |
| Decompression Table No. 1: | |
| 24 pounds for 5 hours, total decompression time. | 117 |
| Decompression Table No. 2: | |
| Stage 1: Reduce pressure from 24 pounds to 8 pounds at the uniform rate of 5 pounds per minute. | |
| Elapsed time stage 1: 16/5 | 3 |
| Stage 2: Reduce pressure at a uniform rate from 8 pounds to 4 pounds over a period of 4 minutes. Rate, 1 pound per minute elapsed time, stage 2 | 4 |
| Transfer men to special decompression chamber maintaining the 4-pound pressure during the transfer operation. | |
| Stage 3 (final stage): In the special decompression chamber, reduce the pressure at a uniform rate from 4 pounds to 0-pound gage over a period of 110 minutes. Rate, 0.037 pound per minute or 27.5 minutes per pound. Stage 3 (final) elapsed time | 110 |
| Total time | 117 |

DECOMPRESSION TABLE NO. 1—TOTAL DECOMPRESSION TIME

| Work pressure | Working period hours | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| p.s.i.g. | ½ | 1 | 1½ | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Over 8 |
| 9–12 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| 14 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 16 | 16 | 33 |
| 16 | 7 | 7 | 7 | 7 | 7 | 7 | 17 | 33 | 48 | 48 | 62 |
| 18 | 7 | 7 | 7 | 8 | 11 | 17 | 48 | 63 | 63 | 73 | 87 |
| 20 | 7 | 7 | 8 | 15 | 15 | 43 | 63 | 73 | 83 | 103 | 113 |
| 22 | 9 | 9 | 16 | 24 | 38 | 68 | 93 | 103 | 113 | 128 | 133 |
| 24 | 11 | 12 | 23 | 27 | 52 | 92 | 117 | 122 | 127 | 137 | 151 |
| 26 | 13 | 14 | 29 | 34 | 69 | 104 | 126 | 141 | 142 | 142 | 163 |
| 28 | 15 | 23 | 31 | 41 | 98 | 127 | 143 | 153 | 153 | 165 | 183 |
| 30 | 17 | 28 | 38 | 62 | 105 | 143 | 165 | 168 | 178 | 188 | 204 |
| 32 | 19 | 35 | 43 | 85 | 126 | 163 | 178 | 193 | 203 | 213 | 226 |
| 34 | 21 | 39 | 58 | 98 | 151 | 178 | 195 | 218 | 223 | 233 | 248 |
| 36 | 24 | 44 | 63 | 113 | 170 | 198 | 223 | 233 | 243 | 253 | 273 |
| 38 | 28 | 49 | 73 | 128 | 178 | 203 | 223 | 238 | 253 | 263 | 278 |
| 40 | 31 | 49 | 84 | 143 | 183 | 213 | 233 | 248 | 258 | 278 | 288 |

DECOMPRESSION TABLE NO. 1—TOTAL DECOMPRESSION TIME—Continued

| Work pressure | Working period hours | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| p.s.i.g. | ½ | 1 | 1½ | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Over 8 |
| 42 | 37 | 56 | 102 | 144 | 189 | 215 | 245 | 260 | 263 | 268 | 293 |
| 44 | 43 | 64 | 118 | 154 | 199 | 234 | 254 | 264 | 269 | 269 | 293 |
| 46 | 44 | 74 | 139 | 171 | 214 | 244 | 269 | 274 | 289 | 299 | 318 |
| 48 | 51 | 89 | 144 | 189 | 229 | 269 | 299 | 309 | 319 | 319 | |
| 50 | 58 | 94 | 164 | 209 | 249 | 279 | 309 | 329 | | | |

DECOMPRESSION TABLE NO. 2

(Do not interpolate, use next higher value for conditions not computed.)

| Working chamber pressure P.s.i.g. | Working period hours | Decompression data | | | | | |
|---|---|---|---|---|---|---|---|
| | | Stage No | Pressure reduction P.s.i.g. | | Time in stage minutes | Pressure reduction rate Min/pound | Total time decompress minutes |
| | | | From | To | | | |
| 14 | ½ | 1 | 14 | 4 | 2 | 0.20 | 6 |
| | | 2 | 4 | 0 | 4 | 1.00 | 6 |
| | 1 | 1 | 14 | 4 | 2 | 0.20 | 6 |
| | | 2 | 4 | 0 | 4 | 1.00 | 6 |
| | 1½ | 1 | 14 | 4 | 2 | 0.20 | 6 |
| | | 2 | 4 | 0 | 4 | 1.00 | 6 |
| | 2 | 1 | 14 | 4 | 2 | 0.20 | 6 |
| | | 2 | 4 | 0 | 4 | 1.00 | 6 |
| | 3 | 1 | 14 | 4 | 2 | 0.20 | 6 |
| | | 2 | 4 | 0 | 4 | 1.00 | 6 |
| | 4 | 1 | 14 | 0 | 2 | 0.20 | 6 |
| | | 2 | 4 | 0 | 4 | 1.00 | 6 |
| | 5 | 1 | 14 | 4 | 2 | 0.20 | 6 |
| | | 2 | 4 | 0 | 4 | 1.00 | 6 |
| | 6 | 1 | 14 | 4 | 2 | 0.20 | |
| | | 2 | 4 | 0 | 4 | 1.00 | 6 |
| | 7 | 1 | 14 | 4 | 2 | 0.20 | |
| | | 2 | 4 | 0 | 14 | 3.50 | 16 |
| | 8 | 1 | 14 | 4 | 2 | 0.20 | |
| | | 2 | 4 | 0 | 14 | 3.50 | 16 |
| | Over 8 | 1 | 14 | 4 | 2 | 0.20 | |
| | | 2 | 4 | 0 | 30 | 7.50 | 32 |
| 16 | ½ | 1 | 16 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 4 | 1.00 | 7 |
| | 1 | 1 | 16 | 4 | 3 | 0.20 | 7 |
| | | 2 | 4 | 0 | 4 | 1.00 | 7 |
| | 1½ | 1 | 16 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 4 | 1.00 | 7 |
| | 2 | 1 | 16 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 4 | 1.00 | 7 |
| | 3 | 1 | 16 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 4 | 1.00 | 7 |
| | 4 | 1 | 14 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 4 | 1.00 | 7 |
| | 5 | 1 | 14 | 4 | 3 | 0.20 | 7 |
| | | 2 | 4 | 0 | 4 | 3.50 | 17 |
| | 6 | 1 | 14 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 30 | 7.50 | 33 |
| | 7 | 1 | 14 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 45 | 11.25 | 48 |
| | 8 | 1 | 14 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 45 | 11.25 | 48 |
| | Over 8 | 1 | 14 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 60 | 15.00 | 63 |
| 18 | ½ | 1 | 18 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 4 | 1.00 | 7 |
| | 1 | 1 | 18 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 4 | 1.00 | 7 |
| | 1½ | 1 | 18 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 4 | 1.00 | 7 |
| | 2 | 1 | 18 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 5 | 1.25 | 8 |
| | 3 | 1 | 18 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 8 | 2.00 | 11 |
| | 4 | 1 | 18 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 14 | 3.50 | 17 |
| | 5 | 1 | 18 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 45 | 11.25 | 48 |
| | 6 | 1 | 18 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 60 | 15.00 | 63 |
| | 7 | 1 | 18 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 60 | 15.00 | 63 |
| | 8 | 1 | 18 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 70 | 17.50 | 73 |

DECOMPRESSION TABLE NO. 2—Continued

(Do not interpolate, use next higher value for conditions not computed.)

| Working chamber pressure P.s.i.g. | Working period hours | Decompression data | | | | | |
|---|---|---|---|---|---|---|---|
| | | Stage No | Pressure reduction P.s.i.g. From | To | Time in stage minutes | Pressure reduction rate Min/pound | Total time decompress minutes |
| | Over 8 | 1 | 18 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 84 | 21.00 | 87 |
| 20 | ½ | 1 | 20 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 4 | 1.00 | 7 |
| | 1 | 1 | 20 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 4 | 1.00 | 7 |
| | 1½ | 1 | 20 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 5 | 1.25 | 8 |
| | 2 | 1 | 20 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 12 | 3.00 | 15 |
| | 3 | 1 | 20 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 12 | 3.00 | 15 |
| | 4 | 1 | 20 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 40 | 10.00 | 43 |
| | 5 | 1 | 20 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 60 | 15.00 | 63 |
| | 6 | 1 | 20 | 4 | 3 | 0.20 | |
| | | 2 | 6 | 0 | 70 | 17.50 | 73 |
| | 7 | 1 | 20 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 80 | 20.00 | 83 |
| | 8 | 1 | 20 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 100 | 25.00 | 103 |
| | Over 8 | 1 | 20 | 4 | 3 | 0.20 | |
| | | 2 | 4 | 0 | 110 | 27.50 | 113 |
| 22 | ½ | 1 | 22 | 6 | 3 | 0.20 | |
| | | 2 | 6 | 0 | 6 | 1.00 | 9 |
| | 1 | 1 | 22 | 6 | 3 | 0.20 | |
| | | 2 | 6 | 0 | 6 | 1.00 | 9 |
| | 1½ | 1 | 22 | 6 | 3 | 0.20 | |
| | | 2 | 6 | 0 | 13 | 2.20 | 16 |
| | 2 | 1 | 22 | 6 | 3 | 0.20 | |
| | | 2 | 6 | 0 | 21 | 3.50 | 24 |
| | 3 | 1 | 22 | 6 | 3 | 0.20 | |
| | | 2 | 6 | 0 | 35 | 5.85 | 38 |
| | 4 | 1 | 22 | 6 | 3 | 0.20 | |
| | | 2 | 6 | 0 | 65 | 10.83 | 68 |
| | 5 | 1 | 22 | 6 | 3 | 0.20 | |
| | | 2 | 6 | 0 | 90 | 15.00 | 93 |
| | 6 | 1 | 22 | 6 | 3 | 0.20 | |
| | | 2 | 6 | 0 | 100 | 16.67 | 103 |
| | 7 | 1 | 22 | 6 | 3 | 0.20 | |
| | | 2 | 6 | 0 | 110 | 18.35 | 113 |
| | 8 | 1 | 22 | 6 | 3 | 0.20 | |
| | | 2 | 6 | 0 | 125 | 20.80 | 128 |
| | Over 8 | 1 | 22 | 6 | 3 | 0.20 | |
| | | 2 | 6 | 0 | 130 | 21.70 | |
| 24 | ½ | 1 | 24 | 8 | 3 | 0.20 | |
| | | 2 | 8 | 4 | 4 | 1.00 | |
| | | 3 | 4 | 0 | 4 | 1.00 | 11 |
| | 1 | 1 | 24 | 8 | 3 | 0.20 | |
| | | 2 | 8 | 4 | 4 | 1.00 | |
| | | 3 | 4 | 0 | 5 | 1.25 | 12 |
| | 1½ | 1 | 24 | 8 | 3 | 0.20 | |
| | | 2 | 8 | 4 | 4 | 1.00 | |
| | | 3 | 4 | 0 | 16 | 4.00 | 23 |
| | 2 | 1 | 24 | 8 | 3 | 0.20 | |
| | | 2 | 8 | 4 | 4 | 1.00 | |
| | | 3 | 4 | 0 | 20 | 5.00 | 27 |
| | 3 | 1 | 24 | 8 | 3 | 0.20 | |
| | | 2 | 8 | 4 | 4 | 1.00 | |
| | | 3 | 4 | 0 | 45 | 11.25 | 52 |
| | 4 | 1 | 24 | 8 | 3 | 0.20 | |
| | | 2 | 8 | 4 | 4 | 1.00 | |
| | | 3 | 4 | 0 | 85 | 21.25 | 92 |
| | 5 | 1 | 24 | 8 | 3 | 0.20 | |
| | | 2 | 8 | 4 | 4 | 1.00 | |
| | | 3 | 4 | 0 | 110 | 27.50 | 117 |
| | 6 | 1 | 24 | 8 | 3 | 0.20 | |
| | | 2 | 8 | 4 | 4 | 1.00 | |
| | | 3 | 4 | 0 | 115 | 28.80 | 122 |
| | 7 | 1 | 24 | 8 | 3 | 0.20 | |
| | | 2 | 8 | 4 | 4 | 1.00 | |
| | | 3 | 4 | 0 | 120 | 30.00 | 127 |
| | 8 | 1 | 24 | 8 | 3 | 0.20 | |
| | | 2 | 8 | 4 | 4 | 1.00 | |
| | | 3 | 4 | 0 | 130 | 32.50 | 137 |
| | Over 8 | 1 | 24 | 8 | 3 | 0.20 | |
| | | 2 | 8 | 4 | 8 | 2.00 | |
| | | 3 | 4 | 0 | 140 | 35.00 | 151 |

DECOMPRESSION TABLE NO. 2—Continued

(Do not interpolate, use next higher value for conditions not computed.)

| Working chamber pressure P.s.i.g. | Working period hours | Stage No | Decompression data: Pressure reduction P.s.i.g. From | To | Time in stage minutes | Pressure reduction rate Min/pound | Total time decompress minutes |
|---|---|---|---|---|---|---|---|
| 26 | ½ | 1 | 26 | 10 | 3 | 0.20 | |
| | | 2 | 10 | 4 | 6 | 1.00 | |
| | | 3 | 4 | 0 | 4 | 1.00 | 13 |
| | 1 | 1 | 26 | 10 | 3 | 0.20 | |
| | | 2 | 10 | 4 | 6 | 1.00 | |
| | | 3 | 4 | 0 | 5 | 1.25 | 14 |
| | 1½ | 1 | 26 | 10 | 3 | 0.20 | |
| | | 2 | 10 | 4 | 6 | 1.00 | |
| | | 3 | 4 | 0 | 20 | 5.00 | 29 |
| | 2 | 1 | 26 | 10 | 3 | 0.20 | |
| | | 2 | 10 | 4 | 6 | 1.00 | |
| | | 3 | 4 | 0 | 25 | 6.25 | 34 |
| | 3 | 1 | 26 | 10 | 3 | 0.20 | |
| | | 2 | 10 | 4 | 6 | 1.00 | |
| | | 3 | 4 | 0 | 60 | 15.00 | 69 |
| | 4 | 1 | 26 | 10 | 3 | 0.20 | |
| | | 2 | 10 | 4 | 6 | 1.00 | |
| | | 3 | 4 | 0 | 95 | 23.75 | 104 |
| | 5 | 1 | 26 | 10 | 3 | 0.20 | |
| | | 2 | 10 | 4 | 8 | 1.33 | |
| | | 3 | 4 | 0 | 115 | 28.80 | 126 |
| | 6 | 1 | 26 | 10 | 3 | 0.20 | |
| | | 2 | 10 | 4 | 8 | 1.33 | |
| | | 3 | 4 | 0 | 130 | 32.50 | 141 |
| | 7 | 1 | 26 | 10 | 3 | 2.20 | |
| | | 2 | 10 | 4 | 9 | 1.50 | |
| | | 3 | 4 | 0 | 130 | 32.50 | 142 |
| | 8 | 1 | 26 | 10 | 3 | 0.20 | |
| | | 2 | 10 | 4 | 9 | 1.50 | |
| | | 3 | 4 | 0 | 130 | 32.50 | 142 |
| | Over 8 | 1 | 26 | 10 | 3 | 0.20 | |
| | | 2 | 10 | 4 | 30 | 5.00 | |
| | | 3 | 4 | 0 | 130 | 32.50 | 163 |
| 28 | ½ | 1 | 28 | 12 | 3 | 0.20 | |
| | | 2 | 12 | 4 | 8 | 1.00 | |
| | | 3 | 4 | 0 | 4 | 1.00 | 15 |
| | 1 | 1 | 28 | 12 | 3 | 0.20 | |
| | | 2 | 12 | 4 | 8 | 1.00 | |
| | | 3 | 4 | 0 | 12 | 3.00 | 23 |
| | 1½ | 1 | 28 | 12 | 3 | 0.20 | |
| | | 2 | 12 | 4 | 8 | 1.00 | |
| | | 3 | 4 | 0 | 20 | 5.00 | 31 |
| | 2 | 1 | 28 | 12 | 3 | 0.20 | |
| | | 2 | 12 | 4 | 8 | 1.00 | |
| | | 3 | 4 | 0 | 30 | 7.50 | 41 |
| | 3 | 1 | 28 | 12 | 3 | 0.20 | |
| | | 2 | 12 | 4 | 10 | 1.25 | |
| | | 3 | 4 | 0 | 85 | 21.20 | 98 |
| | 4 | 1 | 28 | 12 | 3 | 0.20 | |
| | | 2 | 12 | 4 | 14 | 1.75 | |
| | | 3 | 4 | 0 | 110 | 27.50 | 127 |
| | 5 | 1 | 28 | 12 | 3 | 0.20 | |
| | | 2 | 12 | 4 | 20 | 2.50 | |
| | | 3 | 4 | 0 | 120 | 30.00 | 143 |
| | 6 | 1 | 28 | 12 | 3 | 0.20 | |
| | | 2 | 12 | 4 | 20 | 2.50 | |
| | | 3 | 4 | 0 | 130 | 32.50 | 153 |
| | 7 | 1 | 28 | 12 | 3 | 0.20 | |
| | | 2 | 12 | 4 | 20 | 2.50 | |
| | | 3 | 4 | 0 | 120 | 32.50 | 153 |
| | 8 | 1 | 28 | 12 | 3 | 0.20 | |
| | | 2 | 12 | 4 | 32 | 4.00 | |
| | | 3 | 4 | 0 | 130 | 32.50 | 165 |
| | Over 8 | 1 | 28 | 12 | 3 | 0.20 | |
| | | 2 | 12 | 4 | 50 | 6.25 | |
| | | 3 | 4 | 0 | 130 | 32.50 | 183 |
| 30 | ½ | 1 | 30 | 14 | 3 | 0.20 | |
| | | 2 | 14 | 4 | 10 | 1.00 | |
| | | 3 | 4 | 0 | 4 | 1.00 | 17 |
| | 1 | 1 | 30 | 14 | 3 | 0.20 | |
| | | 2 | 14 | 4 | 10 | 1.00 | |
| | | 3 | 4 | 0 | 15 | 3.75 | 28 |
| | 1½ | 1 | 30 | 14 | 3 | 0.20 | |
| | | 2 | 14 | 4 | 10 | 1.00 | |
| | | 3 | 4 | 0 | 25 | 6.25 | 38 |
| | 2 | 1 | 30 | 14 | 3 | 0.20 | |
| | | 2 | 14 | 4 | 14 | 1.40 | |
| | | 3 | 4 | 0 | 45 | 11.25 | 62 |
| | 3 | 1 | 30 | 14 | 3 | 0.20 | |

DECOMPRESSION TABLE NO. 2—Continued

(Do not interpolate, use next higher value for conditions not computed.)

| Working chamber pressure P.s.i.g. | Working period hours | Stage No | Decompression data: Pressure reduction P.s.i.g. From | To | Time in stage minutes | Pressure reduction rate Min/pound | Total time decompress minutes |
|---|---|---|---|---|---|---|---|
| | | 2 | 14 | 4 | 17 | 1.70 | |
| | | 3 | 4 | 0 | 85 | 21.20 | 105 |
| | 4 | 1 | 30 | 14 | 3 | 0.20 | |
| | | 2 | 14 | 4 | 30 | 3.00 | |
| | | 3 | 4 | 0 | 110 | 27.50 | 143 |
| | 5 | 1 | 30 | 14 | 3 | 0.20 | |
| | | 2 | 14 | 4 | 35 | 3.50 | |
| | | 3 | 4 | 0 | 130 | 32.50 | 165 |
| | 6 | 1 | 30 | 14 | 3 | 0.20 | |
| | | 2 | 14 | 4 | 35 | 3.50 | |
| | | 3 | 4 | 0 | 130 | 32.50 | 168 |
| | 7 | 1 | 30 | 14 | 3 | 0.20 | |
| | | 2 | 14 | 4 | 45 | 4.50 | |
| | | 3 | 4 | 0 | 130 | 32.50 | 178 |
| | 8 | 1 | 30 | 14 | 3 | 0.20 | |
| | | 2 | 14 | 4 | 55 | 5.50 | |
| | | 3 | 4 | 0 | 130 | 32.50 | 188 |
| | Over 8 | 1 | 30 | 14 | 3 | 0.20 | |
| | | 2 | 14 | 4 | 71 | 7.10 | |
| | | 3 | 4 | 0 | 130 | 32.50 | 204 |
| 32 | ½ | 1 | 32 | 16 | 3 | 0.20 | |
| | | 2 | 16 | 4 | 12 | 1.00 | |
| | | 3 | 4 | 0 | 4 | 1.00 | 19 |
| | 1 | 1 | 32 | 16 | 3 | 0.20 | |
| | | 2 | 16 | 4 | 12 | 1.00 | |
| | | 3 | 4 | 0 | 20 | 5.00 | 35 |
| | 1½ | 1 | 32 | 16 | 3 | 0.20 | |
| | | 2 | 16 | 4 | 15 | 1.25 | |
| | | 3 | 4 | 0 | 25 | 6.25 | 43 |
| | 2 | 1 | 32 | 16 | 3 | 0.20 | |
| | | 2 | 16 | 4 | 22 | 1.83 | |
| | | 3 | 4 | 0 | 60 | 15.00 | 85 |
| | 3 | 1 | 32 | 16 | 3 | 0.20 | |
| | | 2 | 16 | 4 | 28 | 2.33 | |
| | | 3 | 4 | 0 | 95 | 23.75 | 126 |
| | 4 | 1 | 32 | 16 | 3 | 0.20 | |
| | | 2 | 16 | 4 | 40 | 3.33 | |
| | | 3 | 4 | 0 | 120 | 30.00 | 163 |
| | 5 | 1 | 32 | 16 | 3 | 0.20 | |
| | | 2 | 16 | 4 | 45 | 3.75 | |
| | | 3 | 4 | 0 | 130 | 32.50 | 178 |
| | 6 | 1 | 32 | 16 | 3 | 0.20 | |
| | | 2 | 16 | 4 | 60 | 5.00 | |
| | | 3 | 4 | 0 | 130 | 32.50 | 193 |
| | 7 | 1 | 32 | 16 | 3 | 0.20 | |
| | | 2 | 16 | 4 | 70 | 5.83 | |
| | | 3 | 4 | 0 | 130 | 32.50 | 203 |
| | 8 | 1 | 32 | 16 | 3 | 0.20 | |
| | | 2 | 16 | 4 | 80 | 6.67 | |
| | | 3 | 4 | 0 | 130 | 32.50 | 213 |
| | Over 8 | 1 | 32 | 16 | 3 | 0.20 | |
| | | 2 | 16 | 4 | 93 | 7.75 | |
| | | 3 | 4 | 0 | 130 | 32.50 | 226 |
| 34 | ½ | 1 | 34 | 18 | 3 | 0.20 | |
| | | 2 | 18 | 4 | 14 | 1.00 | |
| | | 3 | 4 | 0 | 4 | 1.00 | 21 |
| | 1 | 1 | 34 | 18 | 3 | 0.20 | |
| | | 2 | 18 | 4 | 14 | 1.00 | |
| | | 3 | 4 | 0 | 22 | 5.50 | 39 |
| | 1½ | 1 | 34 | 18 | 3 | 0.20 | |
| | | 2 | 18 | 4 | 25 | 1.80 | |
| | | 3 | 4 | 0 | 30 | 7.50 | 58 |
| | 2 | 1 | 34 | 18 | 3 | 0.20 | |
| | | 2 | 18 | 4 | 35 | 2.50 | |
| | | 3 | 4 | 0 | 60 | 15.00 | 98 |
| | 3 | 1 | 34 | 18 | 3 | 0.20 | |
| | | 2 | 18 | 4 | 43 | 3.10 | |
| | | 3 | 4 | 0 | 105 | 26.25 | 151 |
| | 4 | 1 | 34 | 18 | 3 | 0.20 | |
| | | 2 | 18 | 4 | 55 | 3.93 | |
| | | 3 | 4 | 0 | 120 | 30.00 | 178 |
| | 5 | 1 | 34 | 18 | 3 | 0.20 | |
| | | 2 | 18 | 4 | 62 | 4.43 | |
| | | 3 | 4 | 0 | 130 | 32.50 | 195 |
| | 6 | 1 | 34 | 18 | 3 | 0.20 | |
| | | 2 | 18 | 4 | 85 | 6.07 | |
| | | 3 | 4 | 0 | 130 | 32.50 | 218 |
| | 7 | 1 | 34 | 18 | 3 | 0.20 | |
| | | 2 | 18 | 4 | 90 | 6.43 | |

DECOMPRESSION TABLE No. 2—Continued

(Do not interpolate, use next higher value for conditions not computed.)

| Working chamber pressure P.s.i.g. | Working period hours | Stage No | Decompression data: Pressure reduction P.s.i.g. From | To | Time in stage minutes | Pressure reduction rate Min/pound | Total time decompress minutes |
|---|---|---|---|---|---|---|---|
| | | 3 | 4 | 0 | 130 | 32.50 | 223 |
| | 8 | 1 | 34 | 18 | 3 | 0.20 | |
| | | 2 | 18 | 4 | 100 | 7.15 | |
| | | 3 | 4 | 0 | 130 | 32.50 | 233 |
| | Over 8 | 1 | 34 | 18 | 3 | 0.20 | |
| | | 2 | 18 | 4 | 115 | 8.23 | |
| | | 3 | 4 | 0 | 130 | 32.50 | 248 |
| 36 | ½ | 1 | 36 | 20 | 3 | 0.20 | |
| | | 2 | 20 | 4 | 16 | 1.00 | |
| | | 3 | 4 | 0 | 5 | 1.25 | 24 |
| | 1 | 1 | 36 | 20 | 3 | 0.20 | |
| | | 2 | 20 | 4 | 16 | 1.00 | |
| | | 3 | 4 | 0 | 25 | 6.25 | 44 |
| | 1½ | 1 | 36 | 20 | 3 | 0.20 | |
| | | 2 | 20 | 4 | 30 | 1.88 | |
| | | 3 | 4 | 0 | 30 | 7.50 | 63 |
| | 2 | 1 | 36 | 20 | 3 | 0.20 | |
| | | 2 | 20 | 4 | 40 | 2.50 | |
| | | 3 | 4 | 0 | 70 | 17.50 | 113 |
| | 3 | 1 | 36 | 20 | 3 | 0.20 | |
| | | 2 | 20 | 4 | 52 | 3.25 | |
| | | 3 | 4 | 0 | 115 | 28.75 | 170 |
| | 4 | 1 | 36 | 20 | 3 | 0.20 | |
| | | 2 | 20 | 4 | 65 | 4.06 | |
| | | 3 | 4 | 0 | 130 | 32.50 | 198 |
| | 5 | 1 | 36 | 20 | 3 | 0.20 | |
| | | 2 | 20 | 4 | 90 | 5.63 | |
| | | 3 | 4 | 0 | 130 | 32.50 | 223 |
| | 6 | 1 | 36 | 20 | 3 | 0.20 | |
| | | 2 | 20 | 4 | 100 | 6.25 | |
| | | 3 | 4 | 0 | 130 | 32.50 | 233 |
| | 7 | 1 | 36 | 20 | 3 | 0.20 | |
| | | 2 | 20 | 4 | 110 | 6.88 | |
| | | 3 | 4 | 0 | 130 | 32.50 | 243 |
| | 8 | 1 | 36 | 20 | 3 | 0.20 | |
| | | 2 | 20 | 4 | 120 | 7.50 | |
| | | 3 | 4 | 0 | 130 | 32.50 | 253 |
| | Over 8 | 1 | 36 | 20 | 3 | 0.20 | |
| | | 2 | 20 | 4 | 140 | 8.75 | |
| | | 3 | 4 | 0 | 130 | 32.50 | 273 |
| 38 | ½ | 1 | 38 | 22 | 3 | 0.20 | |
| | | 2 | 22 | 6 | 16 | 1.00 | |
| | | 3 | 6 | 0 | 9 | 1.50 | 28 |
| | 1 | 1 | 38 | 22 | 3 | 0.20 | |
| | | 2 | 22 | 6 | 16 | 1.00 | |
| | | 3 | 6 | 0 | 30 | 5.00 | 49 |
| | 1½ | 1 | 38 | 22 | 3 | 0.20 | |
| | | 2 | 22 | 6 | 20 | 1.25 | |
| | | 3 | 6 | 0 | 50 | 8.34 | 73 |
| | 2 | 1 | 38 | 22 | 3 | 0.20 | |
| | | 2 | 22 | 6 | 30 | 1.88 | |
| | | 3 | 6 | 0 | 95 | 15.83 | 128 |
| | 3 | 1 | 38 | 22 | 3 | 0.20 | |
| | | 2 | 22 | 6 | 35 | 2.19 | |
| | | 3 | 6 | 0 | 140 | 23.35 | 178 |
| | 4 | 1 | 38 | 22 | 3 | 0.20 | |
| | | 2 | 22 | 6 | 50 | 3.12 | |
| | | 3 | 6 | 0 | 150 | 25.00 | 203 |
| | 5 | 1 | 38 | 22 | 3 | 0.20 | |
| | | 2 | 22 | 6 | 55 | 3.44 | |
| | | 3 | 6 | 0 | 165 | 27.50 | 223 |
| | 6 | 1 | 38 | 22 | 3 | 0.20 | |
| | | 2 | 22 | 6 | 70 | 4.38 | |
| | | 3 | 6 | 0 | 165 | 27.50 | 238 |
| | 7 | 1 | 38 | 22 | 3 | 0.20 | |
| | | 2 | 22 | 6 | 85 | 5.32 | |
| | | 3 | 6 | 0 | 165 | 27.50 | 253 |
| | 8 | 1 | 38 | 22 | 3 | 0.20 | |
| | | 2 | 22 | 6 | 95 | 5.93 | |
| | | 3 | 6 | 0 | 165 | 27.50 | 263 |
| | Over 8 | 1 | 38 | 22 | 3 | 0.20 | |
| | | 2 | 22 | 6 | 110 | 6.88 | |
| | | 3 | 6 | 0 | 165 | 27.50 | 278 |
| 40 | ½ | 1 | 40 | 24 | 3 | 0.20 | |
| | | 2 | 24 | 8 | 16 | 1.00 | |
| | | 3 | 8 | 4 | 4 | 1.00 | |
| | | 4 | 4 | 0 | 8 | 2.00 | 31 |
| | 1 | 1 | 40 | 24 | 3 | 0.20 | |
| | | 2 | 24 | 8 | 16 | 1.00 | |

DECOMPRESSION TABLE NO. 2—Continued

(Do not interpolate, use next higher value for conditions not computed.)

| Working chamber pressure P.s.i.g. | Working period hours | Decompression data | | | | | |
|---|---|---|---|---|---|---|---|
| | | Stage No | Pressure reduction P.s.i.g. | | Time in stage minutes | Pressure reduction rate Min/pound | Total time decompress minutes |
| | | | From | To | | | |
| | | 3 | 8 | 4 | 5 | 1.25 | |
| | | 4 | 4 | 0 | 25 | 6.25 | 49 |
| | 1½ | 1 | 40 | 24 | 3 | 0.20 | |
| | | 2 | 24 | 8 | 16 | 1.00 | |
| | | 3 | 8 | 4 | 20 | 5.00 | |
| | | 4 | 4 | 0 | 45 | 11.25 | 84 |
| | 2 | 2 | 40 | 24 | 3 | 0.20 | |
| | | 1 | 24 | 8 | 25 | 1.56 | |
| | | 3 | 8 | 4 | 20 | 5.00 | |
| | | 4 | 4 | 0 | 95 | 23.75 | 143 |
| | 3 | 1 | 40 | 24 | 3 | 0.20 | |
| | | 2 | 24 | 8 | 30 | 1.88 | |
| | | 3 | 8 | 4 | 30 | 7.50 | |
| | | 4 | 4 | 0 | 120 | 30.00 | 183 |
| | 4 | 1 | 40 | 24 | 3 | 0.20 | |
| | | 2 | 24 | 8 | 45 | 2.81 | |
| | | 3 | 8 | 4 | 35 | 8.75 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 213 |
| | 5 | 1 | 40 | 24 | 3 | 0.20 | |
| | | 2 | 24 | 8 | 47 | 2.94 | |
| | | 3 | 8 | 4 | 53 | 13.25 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 233 |
| | 6 | 1 | 40 | 24 | 3 | 0.20 | |
| | | 2 | 24 | 8 | 55 | 3.44 | |
| | | 3 | 8 | 4 | 60 | 15.00 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 248 |
| | 7 | 1 | 40 | 24 | 3 | 0.20 | |
| | | 2 | 24 | 8 | 65 | 4.06 | |
| | | 3 | 8 | 4 | 60 | 15.00 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 258 |
| | 8 | 1 | 40 | 24 | 3 | 0.20 | |
| | | 2 | 24 | 8 | 75 | 4.70 | |
| | | 3 | 8 | 4 | 60 | 15.00 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 268 |
| | Over 8 | 1 | 40 | 24 | 3 | 0.20 | |
| | | 2 | 24 | 8 | 95 | 5.93 | |
| | | 3 | 8 | 4 | 60 | 15.00 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 288 |
| 42 | ½ | 1 | 42 | 26 | 3 | 0.20 | |
| | | 2 | 26 | 10 | 16 | 1.00 | |
| | | 3 | 10 | 4 | 6 | 1.00 | |
| | | 4 | 4 | 0 | 12 | 3.00 | 37 |
| | 1 | 1 | 42 | 26 | 3 | 0.20 | |
| | | 2 | 26 | 10 | 16 | 1.00 | |
| | | 3 | 10 | 4 | 12 | 2.00 | |
| | | 4 | 4 | 0 | 25 | 6.25 | 56 |
| | 1½ | 1 | 42 | 26 | 3 | 0.20 | |
| | | 2 | 26 | 10 | 16 | 1.00 | |
| | | 3 | 10 | 4 | 23 | 3.83 | |
| | | 4 | 4 | 0 | 60 | 15.00 | 102 |
| | 2 | 1 | 42 | 26 | 3 | 0.20 | |
| | | 2 | 26 | 10 | 16 | 1.00 | |
| | | 3 | 10 | 4 | 30 | 5.00 | |
| | | 4 | 4 | 0 | 95 | 23.75 | 144 |
| | 3 | 1 | 42 | 26 | 3 | 0.20 | |
| | | 2 | 26 | 10 | 16 | 1.00 | |
| | | 3 | 10 | 4 | 50 | 8.34 | |
| | | 4 | 4 | 0 | 120 | 30.00 | 189 |
| | 4 | 1 | 42 | 26 | 3 | 0.20 | |
| | | 2 | 26 | 10 | 17 | 1.06 | |
| | | 3 | 10 | 4 | 65 | 10.83 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 215 |
| | 5 | 1 | 42 | 26 | 3 | 0.20 | |
| | | 2 | 26 | 10 | 27 | 1.69 | |
| | | 3 | 10 | 4 | 85 | 14.18 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 245 |
| | 6 | 1 | 42 | 26 | 3 | 0.20 | |
| | | 2 | 26 | 10 | 27 | 1.69 | |
| | | 3 | 10 | 4 | 100 | 16.67 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 260 |
| | 7 | 1 | 42 | 26 | 3 | 0.20 | |
| | | 2 | 26 | 10 | 30 | 1.88 | |
| | | 3 | 10 | 4 | 100 | 16.67 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 263 |
| | 8 | 1 | 42 | 26 | 3 | 0.20 | |
| | | 2 | 26 | 10 | 35 | 2.19 | |
| | | 3 | 10 | 4 | 100 | 16.67 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 268 |
| | Over 8 | 1 | 42 | 26 | 3 | 0.20 | |
| | | 2 | 26 | 10 | 60 | 3.75 | |

DECOMPRESSION TABLE No. 2—Continued

(Do not interpolate, use next higher value for conditions not computed.)

| Working chamber pressure P.s.i.g. | Working period hours | Decompression data | | | | | |
|---|---|---|---|---|---|---|---|
| | | Stage No | Pressure reduction P.s.i.g. From | To | Time in stage minutes | Pressure reduction rate Min/pound | Total time decompress minutes |
| | | 3 | 10 | 4 | 100 | 16.67 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 293 |
| 44 | ½ | 1 | 44 | 28 | 3 | 0.20 | |
| | | 2 | 28 | 12 | 16 | 1.00 | |
| | | 3 | 12 | 4 | 8 | 1.00 | |
| | | 4 | 4 | 0 | 16 | 4.00 | 43 |
| | 1 | 1 | 44 | 28 | 3 | 0.20 | |
| | | 2 | 28 | 12 | 16 | 1.00 | |
| | | 3 | 12 | 4 | 20 | 2.50 | |
| | | 4 | 4 | 0 | 25 | 6.25 | 64 |
| | 1½ | 1 | 44 | 28 | 3 | 0.20 | |
| | | 2 | 28 | 12 | 16 | 1.00 | |
| | | 3 | 12 | 4 | 27 | 3.38 | |
| | | 4 | 4 | 0 | 72 | 18.00 | 118 |
| | 2 | 1 | 44 | 28 | 3 | 0.20 | |
| | | 2 | 28 | 12 | 16 | 1.00 | |
| | | 3 | 12 | 4 | 40 | 5.00 | |
| | | 4 | 4 | 0 | 95 | 23.75 | 154 |
| | 3 | 1 | 44 | 28 | 3 | 0.20 | |
| | | 2 | 28 | 12 | 16 | 1.00 | |
| | | 3 | 12 | 4 | 60 | 7.50 | |
| | | 4 | 4 | 0 | 120 | 30.00 | 199 |
| | 4 | 1 | 44 | 28 | 3 | 0.20 | |
| | | 2 | 28 | 12 | 16 | 1.00 | |
| | | 3 | 12 | 4 | 85 | 10.62 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 234 |
| | 5 | 1 | 44 | 28 | 3 | 0.20 | |
| | | 2 | 28 | 12 | 16 | 1.00 | |
| | | 3 | 12 | 4 | 105 | 13.13 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 254 |
| | 6 | 1 | 44 | 28 | 3 | 0.20 | |
| | | 2 | 28 | 12 | 16 | 1.00 | |
| | | 3 | 12 | 4 | 115 | 14.38 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 264 |
| | 7 | 1 | 44 | 28 | 3 | 0.20 | |
| | | 2 | 28 | 12 | 16 | 1.00 | |
| | | 3 | 12 | 4 | 120 | 15.00 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 269 |
| | 8 | 1 | 44 | 28 | 3 | 0.20 | |
| | | 2 | 28 | 12 | 16 | 1.00 | |
| | | 3 | 12 | 4 | 120 | 15.00 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 269 |
| | Over 8 | 1 | 44 | 28 | 3 | 0.20 | |
| | | 2 | 28 | 12 | 40 | 2.50 | |
| | | 3 | 12 | 4 | 120 | 15.00 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 293 |
| 46 | ½ | 1 | 46 | 30 | 3 | 0.20 | |
| | | 2 | 30 | 14 | 16 | 1.00 | |
| | | 3 | 14 | 4 | 10 | 1.00 | |
| | | 4 | 4 | 0 | 15 | 3.75 | 44 |
| | 1 | 1 | 46 | 30 | 3 | 0.20 | |
| | | 2 | 30 | 14 | 16 | 1.00 | |
| | | 3 | 14 | 4 | 25 | 2.50 | |
| | | 4 | 4 | 0 | 30 | 7.50 | 74 |
| | 1½ | 1 | 46 | 30 | 3 | 0.20 | |
| | | 2 | 30 | 14 | 16 | 1.00 | |
| | | 3 | 14 | 4 | 35 | 3.50 | |
| | | 4 | 4 | 0 | 85 | 21.20 | 139 |
| | 2 | 1 | 46 | 30 | 3 | 0.20 | |
| | | 2 | 30 | 14 | 16 | 1.00 | |
| | | 3 | 14 | 4 | 47 | 4.70 | |
| | | 4 | 4 | 0 | 105 | 26.25 | 171 |
| | 3 | 1 | 46 | 30 | 3 | 0.20 | |
| | | 2 | 30 | 14 | 16 | 1.00 | |
| | | 3 | 14 | 4 | 65 | 6.50 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 214 |
| | 4 | 1 | 46 | 30 | 3 | 0.20 | |
| | | 2 | 30 | 14 | 16 | 1.00 | |
| | | 3 | 14 | 4 | 95 | 9.50 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 244 |
| | 5 | 1 | 46 | 30 | 3 | 0.20 | |
| | | 2 | 30 | 14 | 16 | 1.00 | |
| | | 3 | 14 | 4 | 120 | 12.00 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 269 |
| | 6 | 1 | 46 | 30 | 3 | 0.20 | |
| | | 2 | 30 | 14 | 16 | 1.00 | |
| | | 3 | 14 | 4 | 125 | 12.50 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 274 |
| | 7 | 1 | 46 | 30 | 3 | 0.20 | |
| | | 2 | 30 | 14 | 16 | 1.00 | |
| | | 3 | 14 | 4 | 140 | 14.00 | |

DECOMPRESSION TABLE No. 2—Continued

(Do not interpolate, use next higher value for conditions not computed.)

| Working chamber pressure P.s.i.g. | Working period hours | Decompression data | | | | | |
|---|---|---|---|---|---|---|---|
| | | Stage No | Pressure reduction P.s.i.g. | | Time in stage minutes | Pressure reduction rate Min/pound | Total time decompress minutes |
| | | | From | To | | | |
| | | 4 | 4 | 0 | 130 | 32.50 | 289 |
| | 8 | 1 | 46 | 30 | 3 | 0.20 | |
| | | 2 | 30 | 14 | 16 | 1.00 | |
| | | 3 | 14 | 4 | 150 | 15.00 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 299 |
| | Over 8 | 1 | 46 | 30 | 3 | 0.20 | |
| | | 2 | 30 | 14 | 25 | 1.56 | |
| | | 3 | 14 | 4 | 160 | 16.00 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 318 |
| 48 | ½ | 1 | 48 | 32 | 3 | 0.20 | |
| | | 2 | 32 | 16 | 16 | 1.00 | |
| | | 3 | 16 | 4 | 12 | 1.00 | |
| | | 4 | 4 | 0 | 20 | 5.00 | 51 |
| | 1 | 1 | 48 | 32 | 3 | 0.20 | |
| | | 2 | 32 | 16 | 16 | 1.00 | |
| | | 3 | 16 | 4 | 35 | 2.92 | |
| | | 4 | 4 | 0 | 35 | 8.75 | 89 |
| | 1½ | 1 | 48 | 32 | 3 | 0.20 | |
| | | 2 | 32 | 16 | 16 | 1.00 | |
| | | 3 | 16 | 4 | 45 | 3.75 | |
| | | 4 | 4 | 0 | 80 | 20.00 | 144 |
| | 2 | 1 | 48 | 32 | 3 | 0.20 | |
| | | 2 | 32 | 16 | 16 | 1.00 | |
| | | 3 | 16 | 4 | 60 | 5.00 | |
| | | 4 | 4 | 0 | 110 | 27.50 | 189 |
| | 3 | 1 | 48 | 32 | 3 | 0.20 | |
| | | 2 | 32 | 16 | 16 | 1.00 | |
| | | 3 | 16 | 4 | 90 | 7.50 | |
| | | 4 | 4 | 0 | 120 | 30.00 | 229 |
| | 4 | 1 | 48 | 32 | 3 | 0.20 | |
| | | 2 | 32 | 16 | 16 | 1.00 | |
| | | 3 | 16 | 4 | 120 | 10.00 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 269 |
| | 5 | 1 | 48 | 32 | 3 | 0.20 | |
| | | 2 | 32 | 16 | 16 | 1.00 | |
| | | 3 | 16 | 4 | 140 | 11.67 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 299 |
| | 6 | 1 | 48 | 32 | 3 | 0.20 | |
| | | 2 | 32 | 16 | 16 | 1.00 | |
| | | 3 | 16 | 4 | 160 | 13.33 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 309 |
| | 7 | 1 | 48 | 32 | 3 | 0.20 | |
| | | 2 | 32 | 16 | 16 | 1.00 | |
| | | 3 | 16 | 4 | 170 | 14.17 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 319 |
| | 8 | 1 | 48 | 32 | 3 | 0.20 | |
| | | 2 | 32 | 16 | 16 | 1.00 | |
| | | 3 | 16 | 4 | 170 | 14.17 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 319 |
| 50 | ½ | 1 | 50 | 34 | 3 | 0.20 | |
| | | 2 | 34 | 18 | 16 | 1.00 | |
| | | 3 | 18 | 4 | 14 | 1.00 | |
| | | 4 | 4 | 0 | 25 | 6.25 | 58 |
| | 1 | 1 | 50 | 34 | 3 | 0.20 | |
| | | 2 | 34 | 18 | 16 | 1.00 | |
| | | 3 | 18 | 4 | 40 | 2.86 | |
| | | 4 | 4 | 0 | 35 | 8.75 | 94 |
| | 1½ | 1 | 50 | 34 | 3 | 0.20 | |
| | | 2 | 34 | 18 | 16 | 1.00 | |
| | | 3 | 18 | 4 | 55 | 3.93 | |
| | | 4 | 4 | 0 | 90 | 22.50 | 164 |

DECOMPRESSION TABLE NO. 2—Continued

(Do not interpolate, use next higher value for conditions not computed.)

| Working chamber pressure P.s.i.g. | Working period hours | Decompression data | | | | | |
|---|---|---|---|---|---|---|---|
| | | Stage No | Pressure reduction P.s.i.g. From | Pressure reduction P.s.i.g. To | Time in stage minutes | Pressure reduction rate Min/pound | Total time decompress minutes |
| | 2 | 1 | 50 | 34 | 3 | 0.20 | |
| | | 2 | 34 | 18 | 16 | 1.00 | |
| | | 3 | 18 | 4 | 70 | 5.00 | |
| | | 4 | 4 | 0 | 120 | 30.00 | 209 |
| | 3 | 1 | 50 | 34 | 3 | 0.20 | |
| | | 2 | 34 | 18 | 16 | 1.00 | |
| | | 3 | 18 | 4 | 100 | 7.15 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 249 |
| | 4 | 1 | 50 | 34 | 3 | 0.20 | |
| | | 2 | 34 | 18 | 16 | 1.00 | |
| | | 3 | 18 | 4 | 130 | 8.58 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 279 |
| | 5 | 1 | 50 | 34 | 3 | 0.20 | |
| | | 2 | 34 | 18 | 16 | 1.00 | |
| | | 3 | 18 | 4 | 160 | 11.42 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 309 |
| | 6 | 1 | 50 | 34 | 3 | 0.20 | |
| | | 2 | 34 | 18 | 16 | 1.00 | |
| | | 3 | 18 | 4 | 180 | 12.85 | |
| | | 4 | 4 | 0 | 130 | 32.50 | 329 |

## Subpart T—Demolition

Sec.

1926.850 Preparatory operations.
1926.851 Stairs, passageways, and ladders.
1926.852 Chutes.
1926.853 Removal of materials through floor openings.
1926.854 Removal of walls, masonry sections, and chimneys.
1926.855 Manual removal of floors.
1926.856 Removal of walls, floors, and material with equipment.
1926.857 Storage.
1926.858 Removal of steel construction.
1926.859 Mechanical demolition.
1926.860 Selective demolition by explosives.

### § 1926.850 Preparatory operations.

(a) Prior to permitting employees to start demolition operations, an engineering survey shall be made, by a competent person, of the structure to determine the condition of the framing, floors, and walls, and possibility of unplanned collapse of any portion of the structure. Any adjacent structure where employees may be exposed shall also be similarly checked. The employer shall have in writing evidence that such a survey has been performed.

(b) When employees are required to work within a structure to be demolished which has been damaged by fire, flood, explosion, or other cause, the walls or floor shall be shored or braced.

(c) All electric, gas, water, steam, sewer, and other service lines shall be shut off, capped, or otherwise controlled, outside the building line before demolition work is started. In each case, any utility company which is involved shall be notified in advance.

(d) If it is necessary to maintain any power, water or other utilities during demolition, such lines shall be temporarily relocated, as necessary, and protected.

(e) It shall also be determined if any type of hazardous chemicals, gases, explosives, flammable materials, or similarly dangerous substances have been used in any pipes, tanks, or other equipment on the property. When the presence of any such substances is apparent or suspected, testing and purging shall be performed and the hazard eliminated before demolition is started.

(f) Where a hazard exists from fragmentation of glass, such hazards shall be removed.

(g) Where a hazard exists to employees falling through wall openings, the opening shall be protected to a height of approximately 42 inches.

(h) When debris is dropped through holes in the floor without the use of chutes, the area onto which the material is dropped shall be completely enclosed with barricades not less than 42 inches high and not less than 6 feet

back from the projected edge of the opening above. Signs, warning of the hazard of falling materials, shall be posted at each level. Removal shall not be permitted in this lower area until debris handling ceases above.

(i) All floor openings, not used as material drops, shall be covered over with material substantial enough to support the weight of any load which may be imposed. Such material shall be properly secured to prevent its accidental movement.

(j) Except for the cutting of holes in floors for chutes, holes through which to drop materials, preparation of storage space, and similar necessary preparatory work, the demolition of exterior walls and floor construction shall begin at the top of the structure and proceed downward. Each story of exterior wall and floor construction shall be removed and dropped into the storage space before commencing the removal of exterior walls and floors in the story next below.

(k) Employee entrances to multistory structures being demolished shall be completely protected by sidewalk sheds or canopies, or both, providing protection from the face of the building for a minimum of 8 feet. All such canopies shall be at least 2 feet wider than the building entrances or openings (1 foot wider on each side thereof), and shall be capable of sustaining a load of 150 pounds per square foot.

**§ 1926.851 Stairs, passageways, and ladders.**

(a) Only those stairways, passageways, and ladders, designated as means of access to the structure of a building, shall be used. Other access ways shall be entirely closed at all times.

(b) All stairs, passageways, ladders and incidental equipment thereto, which are covered by this section, shall be periodically inspected and maintained in a clean safe condition.

(c) In a multistory building, when a stairwell is being used, it shall be properly illuminated by either natural or artificial means, and completely and substantially covered over at a point not less than two floors below the floor on which work is being performed, and access to the floor where the work is in progress shall be through a properly lighted, protected, and separate passageway.

**§ 1926.852 Chutes.**

(a) No material shall be dropped to any point lying outside the exterior walls of the structure unless the area is effectively protected.

(b) All materials chutes, or sections thereof, at an angle of more than 45° from the horizontal, shall be entirely enclosed, except for openings equipped with closures at or about floor level for the insertion of materials. The openings shall not exceed 48 inches in height measured along the wall of the chute. At all stories below the top floor, such openings shall be kept closed when not in use.

(c) A substantial gate shall be installed in each chute at or near the discharge end. A competent employee shall be assigned to control the operation of the gate, and the backing and loading of trucks.

(d) When operations are not in progress, the area surrounding the discharge end of a chute shall be securely closed off.

(e) Any chute opening, into which workmen dump debris, shall be protected by a substantial guardrail approximately 42 inches above the floor or other surface on which the men stand to dump the material. Any space between the chute and the edge of openings in the floors through which it passes shall be solidly covered over.

(f) Where the material is dumped from mechanical equipment or wheelbarrows, a securely attached toeboard or bumper, not less than 4 inches thick and 6 inches high, shall be provided at each chute opening.

(g) Chutes shall be designed and constructed of such strength as to eliminate failure due to impact of materials or debris loaded therein.

**§ 1926.853 Removal of materials through floor openings.**

Any openings cut in a floor for the disposal of materials shall be no larger in size than 25 percent of the aggregate of the total floor area, unless the lateral supports of the removed flooring remain in place. Floors weakened or otherwise made unsafe by demolition operations shall be shored to carry safely the intended imposed load from demolition operations.

**§ 1926.854 Removal of walls, masonry sections, and chimneys.**

(a) Masonry walls, or other sections of masonry, shall not be permitted to fall upon the floors of the building in such masses as to exceed the safe carrying capacities of the floors.

(b) No wall section, which is more than one story in height, shall be permitted to stand alone without lateral bracing, unless such wall was originally designed and constructed to stand without such lateral support, and is in a condition safe enough to be self-supporting. All walls shall be left in a stable condition at the end of each shift.

(c) Employees shall not be permitted to work on the top of a wall when weather conditions constitute a hazard.

(d) Structural or load-supporting members on any floor shall not be cut or removed until all stories above such a floor have been demolished and removed. This provision shall not prohibit the cutting of floor beams for the disposal of materials or for the installation of equipment, provided that the requirements of §§ 1926.853 and 1926.855 are met.

(e) Floor openings within 10 feet of any wall being demolished shall be planked solid, except when employees are kept out of the area below.

(f) In buildings of "skeleton-steel" construction, the steel framing may be left in place during the demolition of masonry. Where this is done, all steel beams, girders, and similar structural supports shall be cleared of all loose material as the masonry demolition progresses downward.

(g) Walkways or ladders shall be provided to enable employees to safely reach or leave any scaffold or wall.

(h) Walls, which serve as retaining walls to support earth or adjoining structures, shall not be demolished until such earth has been properly braced or adjoining structures have been properly underpinned.

(i) Walls, which are to serve as retaining walls against which debris will be piled, shall not be so used unless capable of safely supporting the imposed load.

**§ 1926.855 Manual removal of floors.**

(a) Openings cut in a floor shall extend the full span of the arch between supports.

(b) Before demolishing any floor arch, debris and other material shall be removed from such arch and other adjacent floor area. Planks not less than 2 inches by 10 inches in cross section, full size undressed, shall be provided for, and shall be used by employees to stand on while breaking down floor arches between beams. Such planks shall be so located as to provide a safe support for the workmen should the arch between the beams collapse. The open space between planks shall not exceed 16 inches.

(c) Safe walkways, not less than 18 inches wide, formed of planks not less than 2 inches thick if wood, or of equivalent strength if metal, shall be provided and used by workmen when necessary to enable them to reach any point without walking upon exposed beams.

(d) Stringers of ample strength shall be installed to support the flooring planks, and the ends of such stringers shall be supported by floor beams or girders, and not by floor arches alone.

(e) Planks shall be laid together over solid bearings with the ends overlapping at least 1 foot.

(f) When floor arches are being removed, employees shall not be allowed in the area directly underneath, and

such an area shall be barricaded to prevent access to it.

(g) Demolition of floor arches shall not be started until they, and the surrounding floor area for a distance of 20 feet, have been cleared of debris and any other unnecessary materials.

**§ 1926.856 Removal of walls, floors, and material with equipment.**

(a) Mechanical equipment shall not be used on floors or working surfaces unless such floors or surfaces are of sufficient strength to support the imposed load.

(b) Floor openings shall have curbs or stop-logs to prevent equipment from running over the edge.

(c) Mechanical equipment used shall meet the requirements specified in Subparts N and O of this part.

**§ 1926.857 Storage.**

(a) The storage of waste material and debris on any floor shall not exceed the allowable floor loads.

(b) In buildings having wooden floor construction, the flooring boards may be removed from not more than one floor above grade to provide storage space for debris, provided falling material is not permitted to endanger the stability of the structure.

(c) When wood floor beams serve to brace interior walls or free-standing exterior walls, such beams shall be left in place until other equivalent support can be installed to replace them.

(d) Floor arches, to an elevation of not more than 25 feet above grade, may be removed to provide storage area for debris: *Provided,* That such removal does not endanger the stability of the structure.

(e) Storage space into which material is dumped shall be blocked off, except for openings necessary for the removal of material. Such openings shall be kept closed at all times when material is not being removed.

**§ 1926.858 Removal of steel construction.**

(a) When floor arches have been removed, planking in accordance with § 1926.855(b) shall be provided for the workers engaged in razing the steel framing.

(b) Cranes, derricks, and other hoisting equipment used shall meet the requirements specified in Subpart N of this part.

(c) Steel construction shall be dismantled column length by column length, and tier by tier (columns may be in two-story lengths)..

(d) Any structural member being dismembered shall not be overstressed.

**§ 1926.859 Mechanical demolition.**

(a) No workers shall be permitted in any area, which can be adversely affected by demolition operations, when balling or clamming is being performed. Only those workers necessary for the performance of the operations shall be permitted in this area at any other time.

(b) The weight of the demolition ball shall not exceed 50 percent of the crane's rated load, based on the length of the boom and the maximum angle of operation at which the demolition ball will be used, or it shall not exceed 25 percent of the nominal breaking strength of the line by which it is suspended, whichever results in a lesser value.

(c) The crane boom and loadline shall be as short as possible.

(d) The ball shall be attached to the loadline with a swivel-type connection to prevent twisting of the loadline, and shall be attached by positive means in such manner that the weight cannot become accidentally disconnected.

(e) When pulling over walls or portions thereof, all steel members affected shall have been previously cut free.

(f) All roof cornices or other such ornamental stonework shall be removed prior to pulling walls over.

(g) During demoliton, continuing inspections by a competent person shall be made as the work progresses to detect hazards resulting from weakened or deteriorated floors, or walls, or loosened material. No employee shall be permitted to work where such hazards exist until they are corrected by shoring, bracing, or other effective means.

**§ 1926.860 Selective demolition by explosives.**

Selective demolition by explosives shall be conducted in accordance with the applicable sections of Subpart U of this part.

## Subpart U—Blasting and the Use of Explosives[1]

Sec.

1926.900 General provisions.
*1910.109 Explosives and blasting agents.*
1926.901 Blaster qualifications.
1926.902 Surface transportation of explosives.
1926.903 Underground transportation of explosives.
1926.904 Storage of explosives and blasting agents.
1926.905 Loading of explosives or blasting agents.
*1910.109 Explosives and blasting agents.*
1926.906 Initiation of explosive charges—electric blasting.
1926.907 Use of safety fuse.
1926.908 Use of detonating cord.
1926.909 Firing the blast.
1926.910 Inspection after blasting.
1926.911 Misfires.
1926.912 Underwater blasting.
1926.913 Blasting in excavation work under compressed air.
1926.914 Definitions applicable to this subpart.

[1] Portions of the listed Part 1910 standards have been identified as applicable to construction.

**§ 1926.900 General provisions.**

(a) The employer shall permit only authorized and qualified persons to handle and use explosives.

(b) Smoking, firearms, matches, open flame lamps, and other fires, flame or heat producing devices and sparks shall be prohibited in or near explosive magazines or while explosives are being handled, transported or used.

(c) No person shall be allowed to handle or use explosives while under the influence of intoxicating liquors, narcotics, or other dangerous drugs.

(d) All explosives shall be accounted for at all times. Explosives not being used shall be kept in a locked magazine, unavailable to persons not authorized to handle them. The employer shall maintain an inventory and use record of all explosives. Appropriate authorities shall be notified of any loss, theft, or unauthorized entry into a magazine.

(e) No explosives or blasting agents shall be abandoned.

(f) No fire shall be fought where the fire is in imminent danger of contact with explosives. All employees shall be removed to a safe area and the fire area guarded against intruders.

(g) Original containers, or Class II magazines, shall be used for taking detonators and other explosives from storage magazines to the blasting area.

(h) When blasting is done in congested areas or in proximity to a structure, railway, or highway, or any other installation that may be damaged, the blaster shall take special precautions in the loading, delaying, initiation, and confinement of each blast with mats or other methods so as to control the throw of fragments, and thus prevent bodily injury to employees.

(i) Employees authorized to prepare explosive charges or conduct blasting operations shall use every reasonable precaution including, but not limited to, visual and audible warning signals, flags, or barricades, to ensure employee safety.

(j) Insofar as possible, blasting operations above ground shall be conducted between sunup and sundown.

(k) Due precautions shall be taken to prevent accidental discharge of electric blasting caps from current induced by radar, radio transmitters, lightning, adjacent powerlines, dust storms, or other sources of extraneous electricity. These precautions shall include:

(1) Detonators shall be short-circuited in holes which have been primed and shunted until wired into the blasting circuit.

(2) The suspension of all blasting operations and removal of persons from the blasting area during the approach and progress of an electric storm;

(3) (i) The prominent display of adequate signs, warning against the use of mobile radio transmitters, on all roads within 1,000 feet of blasting operations. Whenever adherence to the 1,000-foot distance would create an operational handicap, a competent person shall be consulted to evaluate the particular situation, and alternative provisions may be made which are adequately designed to prevent any premature firing of electric blasting caps. A description of any such alternatives shall be reduced to writing and shall be certified as meeting the purposes of this subdivision by the competent person consulted. The description shall be maintained at the construction site during the duration of the work, and shall be available for inspection by representatives of the Secretary of Labor.

(ii) Specimens of signs which would meet the requirements of subdivision (i) of this subparagraph (3) are the following:

About 48" x 48"

About 42" x 36"

(4) Ensuring that mobile radio transmitters which are less than 100 feet away from electric blasting caps, in other than original containers, shall be deenergized and effectively locked;

(5) Compliance with the recommendations of The Institute of the Makers of Explosives with regard to blasting in the vicinity of radio transmitters as stipulated in Radio Frequency Energy—A Potential Hazard in the Use of Electric Blasting Caps, IME Publication No. 20, March 1971.

(l) Empty boxes and paper and fiber packing materials, which have previously contained high explosives, shall not be used again for any purpose, but shall be destroyed by burning at an approved location.

(m) Explosives, blasting agents, and blasting supplies that are obviously deteriorated or damaged shall not be used.

(n) Delivery and issue of explosives shall only be made by and to authorized persons and into authorized magazines or approved temporary storage or handling areas.

(o) Blasting operations in the proximity of overhead power lines, communication lines, utility services, or other services and structures shall not be carried on until the operators and/or owners have been notified and measures for safe control have been taken.

(p) The use of black powder shall be prohibited.

(q) All loading and firing shall be directed and supervised by competent persons thoroughly experienced in this field.

(r) All blasts shall be fired electrically with an electric blasting machine or properly designed electric power source, except as provided in § 1926.906 (a) and (r).

The following requirements from 29 CFR Part 1910 (General Industry) habe been identified as applicable to construction (29 CFR 1916.900 *General provisions* (Explosives and Blasting Agents)).

**§ 1910.109 Explosives and blasting agents.**

* * * * * * *

(g) * * *

(2) * * *

(ii) Buildings used for the mixing of blasting agents shall conform to the requirements of this section.

(*a*) Buildings shall be of noncombustible construction or sheet metal on wood studs.

(*b*) Floors in a mixing plant shall be of concrete or of other nonabsorbent materials.

(*c*) All fuel oil storage facilities shall be separated from the mixing plant and located in such a manner that in case of tank rupture, the oil will drain away from the mixing plant building.

(*d*) The building shall be well ventilated.

(*e*) Heating units which do not depend on combustion processes, when properly designed and located, may be used in the building. All direct sources of heat shall be provided exclusively from units located outside the mixing building.

(*f*) All internal-combustion engines used for electric power generation shall be located outside the mixing plant building, or shall be properly ventilated and isolated by a firewall. The exhaust systems on all such engines shall be located so any spark emission cannot be a hazard to any materials in or adjacent to the plant.

* * * * * * *

(h) * * *

(3) * * *

(ii) Buildings used for the mixing of water gels shall conform to the requirements of this subdivision.

(*a*) Buildings shall be of noncombustible construction or sheet metal on wood studs.

(*b*) Floors in a mixing plant shall be of concrete or of other nonabsorbent materials.

(*c*) Where fuel oil is used all fuel oil storage facilities shall be separated from the mixing plant and located in such a manner that in case of tank rupture, the oil will drain away from the mixing plant building.

(*d*) The building shall be well ventilated.

(*e*) Heating units that do not depend on combustion processes, when properly designed and located, may be used in the building. All direct sources of heat shall be provided exclusively from units located outside of the mixing building.

(*f*) All internal-combustion engines used for electric power generation shall be located outside the mixing plant building, or shall be properly ventilated and isolated by a firewall. The exhaust systems on all such engines shall be located so any spark emission cannot be a hazard to any materials in or adjacent to the plant.

* * * * * * *

**§ 1926.901 Blaster qualifications.**

(a) A blaster shall be able to understand and give written and oral orders.

(b) A blaster shall be in good physical condition and not be addicted to narcotics, intoxicants, or similar types of drugs.

(c) A blaster shall be qualified, by reason of training, knowledge, or experience, in the field of transporting, storing, handling, and use of explosives, and have a working knowledge of State and local laws and regulations which pertain to explosives.

(d) Blasters shall be required to furnish satisfactory evidence of competency in handling explosives and performing in a safe manner the type of blasting that will be required.

(e) The blaster shall be knowledgeable and competent in the use of each type of blasting method used.

**§ 1926.902 Surface transportation of explosives.**

(a) Transportation of explosives shall meet the provisions of Department of Transportation regulations contained in 14 CFR Part 103, Air Transportation; 46 CFR Parts 146-149, Water Carriers; 49 CFR Parts 171-179, Highways and Railways; 49 CFR Part 180, Pipelines; and 49 CFR Parts 390-397, Motor Carriers.

(b) Motor vehicles or conveyances transporting explosives shall only be driven by, and be in the charge of, a licensed driver who is physically fit. He shall be familiar with the local, State, and Federal regulation governing the transportation of explosives.

(c) No person shall smoke, or carry matches or any other flame-producing device, nor shall firearms or loaded cartridges be carried while in or near a motor vehicle or conveyance transporting explosives.

(d) Explosives, blasting agents, and blasting supplies shall not be transported with other materials or cargoes. Blasting caps (including electric) shall not be transported in the same vehicle with other explosives.

(e) Vehicles used for transporting explosives shall be strong enough to carry the load without difficulty, and shall be in good mechanical condition.

(f) When explosives are transported by a vehicle with an open body, a Class II magazine or original manufacturer's container shall be securely mounted on the bed to contain the cargo.

(g) All vehicles used for the transportation of explosives shall have tight floors and any exposed spark-producing metal on the inside of the body shall be covered with wood, or other nonsparking material, to prevent contact with containers of explosives.

(h) Every motor vehicle or conveyance used for transporting explosives shall be marked or placarded on both sides, the front, and the rear with the word "Explosives" in red letters, not less than 4 inches in height, on white background. In addition to such marking or placarding, the motor vehicle or conveyance may display, in such a manner that it will be readily visible from all directions, a red flag 18 inches by 30 inches, with the word "Explosives" painted, stamped, or sewed thereon, in white letters, at least 6 inches in height.

(i) Each vehicle used for transportation of explosives shall be equipped with a fully charged fire extinguisher, in good condition. An Underwriters' Laboratory-approved extinguisher of not less than 10-ABC rating will meet the minimum requirement. The driver shall be trained in the use of the extinguisher on his vehicle.

(j) Motor vehicles or conveyances carrying explosives, blasting agents, or blasting supplies, shall not be taken inside a garage or shop for repairs or servicing.

(k) No motor vehicle transporting explosives shall be left unattended.

**§ 1926.903 Underground transportation of explosives.**

(a) All explosives or blasting agents in transit underground shall be taken to the place of use or storage without delay.

(b) The quantity of explosives or blasting agents taken to an underground loading area shall not exceed the amount estimated to be necessary for the blast.

(c) Explosives in transit shall not be left unattended.

(d) The hoist operator shall be notified before explosives or blasting agents are transported in a shaft conveyance.

(e) Trucks used for the transportation of explosives underground shall have the electrical system checked weekly to detect any failures which may constitute an electrical hazard. A written record of such inspections shall be kept on file.

(f) The installation of auxiliary lights on truck beds, which are powered by the truck's electrical system, shall be prohibited.

(g) Explosives and blasting agents shall be hoisted, lowered, or conveyed in a powder car. No other materials, supplies, or equipment shall be transported in the same conveyance at the same time.

(h) No one, except the operator, his helper, and the powderman, shall be permitted to ride on a conveyance transporting explosives and blasting agents.

(i) No person shall ride in any shaft conveyance transporting explosives and blasting agents.

(j) No explosives or blasting agents shall be transported on any locomotive. At least two car lengths shall separate the locomotive from the powder car.

(k) No explosives or blasting agents shall be transported on a man haul trip.

(l) The car or conveyance containing explosives or blasting agents shall be pulled, not pushed, whenever possible.

(m) The powder car or conveyance especially built for the purpose of transporting explosives or blasting agents shall bear a reflectorized sign on each side with the word "Explosives" in letters, not less than 4 inches in height; upon a background of sharply contrasting color.

(n) Compartments for transporting detonators and explosives in the same car or conveyance shall be physically separated by a distance of 24 inches or by a solid partition at least 6 inches thick.

(o) Detonators and other explosives shall not be transported at the same time in any shaft conveyance.

(p) Explosives, blasting agents, or blasting supplies shall not be transported with other materials.

(q) Explosives or blasting agents, not in original containers, shall be placed in a suitable container when transported manually.

(r) Detonators, primers, and other explosives shall be carried in separate containers when transported manually.

**§ 1926.904 Storage of explosives and blasting agents.**

(a) Explosives and related materials shall be stored in approved facilities required under the applicable provisions of the Internal Revenue Service regulations contained in 26 CFR 181, Commerce in Explosives.

(b) Blasting caps, electric blasting caps, detonating primers, and primed cartridges shall not be stored in the same magazine with other explosives or blasting agents.

(c) Smoking and open flames shall not be permitted within 50 feet of explosives and detonator storage magazine.

(d) No explosives or blasting agents shall be permanently stored in any underground operation until the operation has been developed to the point where at least two modes of exit have been provided.

(e) Permanent underground storage magazines shall be at least 300 feet from any shaft, adit, or active underground working area.

(f) Permanent underground magazines containing detonators shall not be located closer than 50 feet to any magazine containing other explosives or blasting agents.

**§ 1926.905 Loading of explosives or blasting agents.**

(a) Procedures that permit safe and efficient loading shall be established before loading is started.

(b) All drill holes shall be sufficiently large to admit freely the insertion of the cartridges of explosives.

(c) Tamping shall be done only with wood rods or plastic tamping poles without exposed metal parts, but nonsparking metal connectors may be used for jointed poles. Violent tamping shall be avoided. The primer shall never be tamped.

(d) No holes shall be loaded except those to be fired in the next round of blasting. After loading, all remaining explosives and detonators shall be immediately returned to an authorized magazine.

(e) Drilling shall not be started until all remaining butts of old holes are examined for unexploded charges, and if any are found, they shall be refired before work proceeds.

(f) No person shall be allowed to deepen drill holes which have contained explosives or blasting agents.

(g) No explosives or blasting agents shall be left unattended at the blast site.

(h) Machines and all tools not used for loading explosives into bore holes shall be removed from the immediate

location of holes before explosives are delivered. Equipment shall not be operated within 50 feet of loaded holes.

(i) No activity of any nature other than that which is required for loading holes with explosives shall be permitted in a blast area.

(j) Powerlines and portable electric cables for equipment being used shall be kept a safe distance from explosives or blasting agents being loaded into drill holes. Cables in the proximity of the blast area shall be deenergized and locked out by the blaster.

(k) Holes shall be checked prior to loading to determine depth and conditions. Where a hole has been loaded with explosives but the explosives have failed to detonate, there shall be no drilling within 50 feet of the hole.

(l) When loading a long line of holes with more than one loading crew, the crews shall be separated by practical distance consistent with efficient operation and supervision of crews.

(m) No explosive shall be loaded or used underground in the presence of combustible gases or combustible dusts.

(n) No explosives other than those in Fume Class 1, as set forth by the Institute of Makers of Explosives, shall be used; however, explosives complying with the requirements of Fume Class 2 and Fume Class 3 may be used if adequate ventilation has been provided.

(o) All blast holes in open work shall be stemmed to the collar or to a point which will confine the charge.

(p) Warning signs, indicating a blast area, shall be maintained at all approaches to the blast area. The warning sign lettering shall not be less than 4 inches in height on a contrasting background.

(q) A bore hole shall never be sprung when it is adjacent to or near a hole that is loaded. Flashlight batteries shall not be used for springing holes.

(r) Drill holes which have been sprung or chambered, and which are not water-filled, shall be allowed to cool before explosives are loaded.

(s) No loaded holes shall be left unattended or unprotected.

(t) The blaster shall keep an accurate, up-to-date record of explosives, blasting agents, and blasting supplies used in a blast and shall keep an accurate running inventory of all explosives and blasting agents stored on the operation.

The following requirement from 29 CFR Part 1910 (General Industry) have been identified as applicable to construction (29 CFR 1926.905 *Loading of explosives or blasting agents*), in accordance with the definition noted below.

**§ 1910.109 Explosives and blasting agents.**

(a) * * *

(12) *Semiconductive hose.* Semiconductive hose—a hose with an electrical resistance high enough to limit flow of stray electric currents to safe levels, yet not so high as to prevent drainage of static electric charges to ground; hose of not more than 2 megohms resistance over its entire length and of not less than 5,000 ohms per foot meets the requirement.

* * * * *

(e) * * *

(3) * * *

(iii) When loading blasting agents pneumatically over electric blasting caps, semiconductive delivery hose shall be used and the equipment shall be bonded and grounded.

* * * * *

---

**§ 1926.906 Initiation of explosive charges—electric blasting.**

(a) Electric blasting caps shall not be used where sources of extraneous electricity make the use of electric blasting caps dangerous. Blasting cap leg wires shall be kept short-circuited (shunted) until they are connected into the circuit for firing.

(b) Before adopting any system of electrical firing, the blaster shall conduct a thorough survey for extraneous currents, and all dangerous currents shall be eliminated before any holes are loaded.

(c) In any single blast using electric blasting caps, all caps shall be of the same style or function, and of the same manufacture.

(d) Electric blasting shall be carried out by using blasting circuits or power circuits in accordance with the electric blasting cap manufacturer's recommendations, or an approved contractor or his designated representative.

(e) When firing a circuit of electric blasting caps, care must be exercised to ensure that an adequate quantity of delivered current is available, in accordance with the manufacturer's recommendations.

(f) Connecting wires and lead wires shall be insulated single solid wires of sufficient current-carrying capacity.

(g) Bus wires shall be solid single wires of sufficient current-carrying capacity.

(h) When firing electrically, the insulation on all firing lines shall be adequate and in good condition.

(i) A power circuit used for firing electric blasting caps shall not be grounded.

(j) In underground operations when firing from a power circuit, a safety switch shall be placed in the permanent firing line at intervals. This switch shall be made so it can be locked only in the "Off" position and shall be provided with a short-circuiting arrangement of the firing lines to the cap circuit.

(k) In underground operations there shall be a "lightning" gap of at least 5 feet in the firing system ahead of the main firing switch; that is, between this switch and the source of power. This gap shall be bridged by a flexible jumper cord just before firing the blast.

(l) When firing from a power circuit, the firing switch shall be locked in the open or "Off" position at all times, except when firing. It shall be so designed that the firing lines to the cap circuit are automatically short-circuited when the switch is in the "Off" position. Keys to this switch shall be entrusted only to the blaster.

(m) Blasting machines shall be in good condition and the efficiency of the machine shall be tested periodically to make certain that it can deliver power at its rated capacity.

(n) When firing with blasting machines, the connections shall be made as recommended by the manufacturer of the electric blasting caps used.

(o) The number of electric blasting caps connected to a blasting machine shall not be in excess of its rated capacity. Furthermore, in primary blasting, a series circuit shall contain no more caps than the limits recommended by the manufacturer of the electric blasting caps in use.

(p) The blaster shall be in charge of the blasting machines, and no other person shall connect the leading wires to the machine.

(q) Blasters, when testing circuits to charged holes, shall use only blasting galvanometers equipped with a silver chloride cell especially designed for this purpose.

(r) Whenever the possibility exists that a leading line or blasting wire might be thrown over a live powerline by the force of an explosion, care shall be taken to see that the total length of wires are kept too short to hit the lines, or that the wires are securely anchored to the ground. If neither of these requirements can be satisfied, a nonelectric system shall be used.

(s) In electrical firing, only the man making leading wire connections shall fire the shot. All connections shall be made from the bore hole back to the source of firing current, and the leading wires shall remain shorted and not be connected to the blasting machine or other source of current until the charge is to be fired.

(t) After firing an electric blast from a blasting machine, the leading wires shall be immediately disconnected from the machine and short-circuited.

§ 1926.907 Use of safety fuse.

(a) Safety fuse shall only be used where sources of extraneous electricity make the use of electric blasting caps dangerous. The use of a fuse that has been hammered or injured in any way shall be forbidden.

(b) The hanging of a fuse on nails or other projections which will cause a sharp bend to be formed in the fuse is prohibited.

(c) Before capping safety fuse, a short length shall be cut from the end of the supply reel so as to assure a fresh cut end in each blasting cap.

(d) Only a cap crimper of approved design shall be used for attaching blasting caps to safety fuse. Crimpers shall be kept in good repair and accessible for use.

(e) No unused cap or short capped fuse shall be placed in any hole to be blasted; such unused detonators shall be removed from the working place and destroyed.

(f) No fuse shall be capped, or primers made up, in any magazine or near any possible source of ignition.

(g) No one shall be permitted to carry detonators or primers of any kind on his person.

(h) The minimum length of safety fuse to be used in blasting shall be as required by State law, but shall not be less than 30 inches.

(i) At least two men shall be present when multiple cap and fuse blasting is done by hand lighting methods.

(j) Not more than 12 fuses shall be lighted by each blaster when hand lighting devices are used. However, when two or more safety fuses in a group are lighted as one by means of igniter cord, or other similar fuse-lighting devices, they may be considered as one fuse.

(k) The so-called "drop fuse" method of dropping or pushing a primer or any explosive with a lighted fuse attached is forbidden.

(l) Cap and fuse shall not be used for firing mudcap charges unless charges are separated sufficiently to prevent one charge from dislodging other shots in the blast.

(m) When blasting with safety fuses, consideration shall be given to the length and burning rate of the fuse. Sufficient time, with a margin of safety, shall always be provided for the blaster to reach a place of safety.

§ 1926.908 Use of detonating cord.

(a) Care shall be taken to select a detonating cord consistent with the type and physical condition of the bore hole and stemming and the type of explosives used.

(b) Detonating cord shall be handled and used with the same respect and care given other explosives.

(c) The line of detonating cord extending out of a bore hole or from a charge shall be cut from supply spool before loading the remainder of the bore hole or placing additional charges.

(d) Detonating cord shall be handled and used with care to avoid damaging or severing the cord during and after loading and hooking-up.

(e) Detonating cord connections shall be competent and positive in accordance with approved and recommended methods. Knot-type or other cord-to-cord connections shall be made only with detonating cord in which the explosive core is dry.

(f) All detonating cord trunklines and branchlines shall be free of loops, sharp kinks, or angles that direct the cord back toward the oncoming line of detonation.

(g) All detonating cord connections shall be inspected before firing the blast.

(h) When detonating cord millisecond-delay connectors or short-interval-delay electric blasting caps are used with detonating cord, the practice shall conform strictly to the manufacturer's recommendations.

(i) When connecting a blasting cap or an electric blasting cap to detonating cord, the cap shall be taped or otherwise attached securely along the side or the end of the detonating cord, with the end of the cap containing the explosive charge pointed in the direction in which the detonation is to proceed.

(j) Detonators for firing the trunkline shall not be brought to the loading area nor attached to the detonating cord until everything else is in readiness for the blast.

§ 1926.909 Firing the blast.

(a) A code of blasting signals equivalent to Table U-1, shall be posted on one or more conspicuous places at the operation, and all employees shall be required to familiarize themselves with the code and conform to it. Danger signs shall be placed at suitable locations.

(b) Before a blast is fired, a loud warning signal shall be given by the blaster in charge, who has made certain that all surplus explosives are in a safe place and all employees, vehicles, and equipment are at a safe distance, or under sufficient cover.

(c) Flagmen shall be safely stationed on highways which pass through the danger zone so as to stop traffic during blasting operations.

(d) It shall be the duty of the blaster to fix the time of blasting.

(e) Before firing an underground blast, warning shall be given, and all possible entries into the blasting area, and any entrances to any working place where a drift, raise, or other opening is about to hole through, shall be carefully guarded. The blaster shall make sure that all employees are out of the blast area before firing a blast.

TABLE U-1

WARNING SIGNAL—A 1-minute series of long blasts 5 minutes prior to blast signal.

BLAST SIGNAL—A series of short blasts 1 minute prior to the shot.

ALL CLEAR SIGNAL—A prolonged blast following the inspection of blast area.

§ 1926.910 Inspection after blasting.

(a) Immediately after the blast has been fired, the firing line shall be disconnected from the blasting machine, or where power switches are used, they shall be locked open or in the off position.

(b) Sufficient time shall be allowed, not less than 15 minutes in tunnels, for the smoke and fumes to leave the blasted area before returning to the shot. An inspection of the area and the surrounding rubble shall be made by the blaster to determine if all charges have been exploded before employees are allowed to return to the operation, and in tunnels, after the muck pile has been wetted down.

§ 1926.911 Misfires.

(a) If a misfire is found, the blaster shall provide proper safeguards for excluding all employees from the danger zone.

(b) No other work shall be done except that necessary to remove the hazard of the misfire and only those employees necessary to do the work shall remain in the danger zone.

(c) No attempt shall be made to extract explosives from any charged or misfired hole; a new primer shall be put in and the hole reblasted. If refiring of the misfired hole presents a hazard, the explosives may be removed by washing out with water or, where the misfire is under water, blown out with air.

(d) If there are any misfires while using cap and fuse, all employees shall remain away from the charge for at least 1 hour. Misfires shall be handled under the direction of the person in charge of the blasting. All wires shall be carefully traced and a search made for unexploded charges.

(e) No drilling, digging, or picking shall be permitted until all missed holes have been detonated or the authorized representative has approved that work can proceed.

§ 1926.912 Underwater blasting.

(a) A blaster shall conduct all blasting operations, and no shot shall be fired without his approval.

(b) Loading tubes and casings of dissimilar metals shall not be used because of possible electric transient cur-

rents from galvanic action of the metals and water.

(c) Only water-resistant blasting caps and detonating cords shall be used for all marine blasting. Loading shall be done through a nonsparking metal loading tube when tube is necessary.

(d) No blast shall be fired while any vessel under way is closer than 1,500 feet to the blasting area. Those on board vessels or craft moored or anchored within 1,500 feet shall be notified before a blast is fired.

(e) No blast shall be fired while any swimming or diving operations are in progress in the vicinity of the blasting area. If such operations are in progress, signals and arrangements shall be agreed upon to assure that no blast shall be fired while any person is in the water.

(f) Blasting flags shall be displayed.

(g) The storage and handling of explosives aboard vessels used in underwater blasting operations shall be according to provisions outlined herein on handling and storing explosives.

(h) When more than one charge is placed under water, a float device shall be attached to an element of each charge in such manner that it will be released by the firing. Misfires shall be handled in accordance with the requirements of § 1926.911.

**§ 1926.913 Blasting in excavation work under compressed air.**

(a) Detonators and explosives shall not be stored or kept in tunnels, shafts, or caissons. Detonators and explosives for each round shall be taken directly from the magazines to the blasting zone and immediately loaded. Detonators and explosives left over after loading a round shall be removed from the working chamber before the connecting wires are connected up.

(b) When detonators or explosives are brought into an air lock, no employee except the powderman, blaster, lock tender and the employees necessary for carrying, shall be permitted to enter the air lock. No other material, supplies, or equipment shall be locked through with the explosives.

(c) Detonators and explosives shall be taken separately into pressure working chambers.

(d) The blaster or powderman shall be responsible for the receipt, unloading, storage, and on-site transportation of explosives and detonators.

(e) All metal pipes, rails, air locks, and steel tunnel lining shall be electrically bonded together and grounded at or near the portal or shaft, and such pipes and rails shall be cross-bonded together at not less than 1,000-foot intervals throughout the length of the tunnel. In addition, each low air supply pipe shall be grounded at its delivery end.

(f) The explosives suitable for use in wet holes shall be water-resistant and shall be Fume Class 1.

(g) When tunnel excavation in rock face is approaching mixed face, and when tunnel excavation is in mixed face, blasting shall be performed with light charges and with light burden on each hole. Advance drilling shall be performed as tunnel excavation in rock face approaches mixed face, to determine the general nature and extent of rock cover and the remaining distance ahead to soft ground as excavation advances.

**§ 1926.914 Definitions applicable to this subpart.**

(a) "American Table of Distances" (also known as Quantity Distance Tables) means American Table of Distances for Storage of Explosives as revised and approved by the Institute of the Makers of Explosives, June 5, 1964.

(b) "Approved storage facility"—A facility for the storage of explosive materials conforming to the requirements of this part and covered by a license or permit issued under authority of the Internal Revenue Service. (See 26 CFR Part 181.)

(c) "Blast area"—The area in which explosives loading and blasting operations are being conducted.

(d) "Blaster"—The person or persons authorized to use explosives for blasting purposes and meeting the qualifications contained in § 1926.901.

(e) "Blasting agent"—A blasting agent is any material or mixture consisting of a fuel and oxidizer used for blasting, but not classified an explosive and in which none of the ingredients is classified as an explosive provided the furnished (mixed) product cannot be detonated with a No. 8 test blasting cap when confined. A common blasting agent presently in use is a mixture of ammonium nitrate ($NH_4NO_3$) and carbonaceous combustibles, such as fuel oil or coal, and may either be procured, premixed and packaged from explosives companies or mixed in the field.

(f) "Blasting cap"—A metallic tube closed at one end, containing a charge of one or more detonating compounds, and designed for and capable of detonation from the sparks or flame from a safety fuse inserted and crimped into the open end.

(g) "Block holing"—The breaking of boulders by firing a charge of explosives that has been loaded in a drill hole.

(h) "Conveyance"—Any unit for transporting explosives or blasting agents, including but not limited to trucks, trailers, rail cars, barges, and vessels.

(i) "Detonating cord"—A flexible cord containing a center core of high explosives which when detonated, will have sufficient strength to detonate other cap-sensitive explosives with which it is in contact.

(j) "Detonator"—Blasting caps, electric blasting caps, delay electric blasting caps, and nonelectric delay blasting caps.

(k) "Electric blasting cap"—A blasting cap designed for and capable of detonation by means of an electric current.

(l) "Electric blasting circuitry"—(1) Bus wire. An expendable wire, used in parallel or series, in parallel circuits, to which are connected the leg wires of electric blasting caps.

(2) Connecting wire. An insulated expendable wire used between electric blasting caps and the leading wires or between the bus wire and the leading wires.

(3) Leading wire. An insulated wire used between the electric power source and the electric blasting cap circuit.

(4) Permanent blasting wire. A permanently mounted insulated wire used between the electric power source and the electric blasting cap circuit.

(m) "Electric delay blasting caps"—Caps designed to detonate at a predetermined period of time after energy is applied to the ignition system.

(n) "Explosives"—(1) Any chemical compound, mixture, or device, the primary or common purpose of which is to function by explosion; that is, with substantially instantaneous release of gas and heat, unless such compound, mixture or device is otherwise specifically classified by the U.S. Department of Transportation.

(2) All material which is classified as Class A, Class B, and Class C Explosives by the U.S. Department of Transportation.

(3) Classification of explosives by the U.S. Department of Transportation is as follows:

*Class A Explosives.* Possessing detonating hazard, such as dynamite, nitroglycerin, picric acid, lead azide, fulminate of mercury, black powder, blasting caps, and detonating primers.

*Class B Explosives.* Possessing flammable hazard, such as propellant explosives, including some smokeless propellants.

*Class C Explosives.* Include certain types of manufactured articles which contain Class A or Class B explosives, or both, as components, but in restricted quantities.

(o) "Fuse lighters"—Special devices for the purpose of igniting safety fuse.

(p) "Magazine"—Any building or structure, other than an explosives manufacturing building, used for the storage of explosives.

(q) "Misfire"—An explosive charge which failed to detonate.

(r) "Mud-capping" (sometimes known as bulldozing, adobe blasting, or dobying). The blasting of boulders by placing a quantity of explosives against a rock, boulder, or other object

without confining the explosives in a drill hole.

(s) "Nonelectric delay blasting cap"—A blasting cap with an integral delay element in conjunction with and capable of being detonated by a detonation impulse or signal from miniaturized detonating cord.

(t) "Primary blasting"—The blasting operation by which the original rock formation is dislodged from its natural location.

### Subpart V—Power Transmission and Distribution

Sec.
1926.950 General requirements.
1926.951 Tools and protective equipment.
1926.952 Mechanical equipment.
1926.953 Material handling.
1926.954 Grounding for protection of employees.
1926.955 Overhead lines.
1926.956 Underground lines.
1926.957 Construction in energized substations.
1926.958 External load helicopetes.
1926.959 Lineman's body belts, safety straps, and lanyards.
1926.960 Definitions applicable to this subpart.

### § 1926.950 General requirements.

(a) *Application.* The occupational safety and health standards contained in this Subpart V shall apply to the construction of electric transmission and distribution lines and equipment.

(1) As used in this Subpart V the term "construction" includes the erection of new electric transmission and distribution lines and equipment, and the alteration, conversion, and improvement of existing electric transmission and distribution lines and equipment.

(2) Existing electric transmission and distribution lines and electrical equipment need not be modified to conform to the requirements of applicable standards in this Subpart V, until such work as described in subparagraph (1) of this paragraph is to be performed on such lines or equipment.

(3) The standards set forth in this Subpart V provide minimum requirements for safety and health. Employers may require adherence to additional standards which are not in conflict with the standards contained in this Subpart V.

(b) *Initial inspections, tests, or determinations.* (1) Existing conditions shall be determined before starting work, by an inspection or a test. Such conditions shall include, but not be limited to, energized lines and equipment, conditions of poles, and the location of circuits and equipment, including power and communication lines, CATV and fire alarm circuits.

(2) Electric equipment and lines shall be considered energized until determined to be deenergized by tests or other appropriate methods or means.

(3) Operating voltage of equipment and lines shall be determined before working on or near energized parts.

(c) *Clearances.* The provisions of subparagraph (1) or (2) of this paragraph shall be observed.

(1) No employee shall be permitted to approach or take any conductive object without an approved insulating handle closer to exposed energized parts than shown in Table V-1, unless:

(i) The employee is insulated or guarded from the energized part (gloves or gloves with sleeves rated for the voltage involved shall be considered insulation of the employee from the energized part), or

(ii) The energized part is insulated or guarded from him and any other conductive object at a different potential, or

(iii) The employee is isolated, insulated, or guarded from any other conductive object(s), as during live-line bare-hand work.

(2) (i) The minimum working distance and minimum clear hot stick distances stated in Table V-1 shall not be violated. The minimum clear hot stick distance is that for the use of live-line tools held by linemen when performing live-line work.

(ii) Conductor support tools, such as link sticks, strain carriers, and insulator cradles, may be used: *Provided,* That the clear insulation is at least as long as the insulator string or the minimum distance specified in Table V-1 for the operating voltage.

TABLE V-1

ALTERNATING CURRENT—MINIMUM DISTANCES

| *Voltage range (phase to phase) kilovolt* | *Minimum working and clear hot stick distance* |
|---|---|
| 2.1 to 15 | 2 ft. 0 in. |
| 15.1 to 35 | 2 ft. 4 in. |
| 35.1 to 46 | 2 ft. 6 in. |
| 46.1 to 72.5 | 3 ft. 0 in. |
| 72.6 to 121 | 3 ft. 4 in. |
| 138 to 145 | 3 ft. 6 in. |
| 161 to 169 | 3 ft. 8 in. |
| 230 to 242 | 5 ft. 0 in. |
| 345 to 362 | [1]7 ft. 0 in. |
| 500 to 552 | [1]11 ft. 0 in. |
| 700 to 765 | [1]15 ft. 0 in. |

[1] NOTE: For 345-362 kv., 500-552 kv., and 700-765 kv., the minimum working distance and the minimum clear hot stick distance may be reduced provided that such distances are not less than the shortest distance between the energized part and a grounded surface.

(d) *Deenergizing lines and equipment.* (1) When deenergizing lines and equipment operated in excess of 600 volts, and the means of disconnecting from electric energy is not visibly open or visibly locked out, the provisions of subdivisions (i) through (vii) of this subparagraph shall be complied with:

(i) The particular section of line or equipment to be deenergized shall be clearly identified, and it shall be isolated from all sources of voltage.

(ii) Notification and assurance from the designated employee shall be obtained that:

(*a*) All switches and disconnectors through which electric energy may be supplied to the particular section of line or equipment to be worked have been deenergized;

(*b*) All switches and disconnectors are plainly tagged indicating that men are at work;

(c) And that where design of such switches and disconnectors permits, they have been rendered inoperable.

(iii) After all designated switches and disconnectors have been opened, rendered inoperable, and tagged, visual inspection or tests shall be conducted to insure that equipment or lines have been deenergized.

(iv) Protective grounds shall be applied on the disconnected lines or equipment to be worked on.

(v) Guards or barriers shall be erected as necessary to adjacent energized lines.

(vi) When more than one independent crew requires the same line or equipment to be deenergized, a prominent tag for each such independent crew shall be placed on the line or equipment by the designated employee in charge.

(vii) Upon completion of work on deenergized lines or equipment, each designated employee in charge shall determine that all employees in his crew are clear, that protective grounds installed by his crew have been removed, and he shall report to the designated authority that all tags protecting his crew may be removed.

(2) When a crew working on a line or equipment can clearly see that the means of disconnecting from electric energy are visibly open or visibly locked-out, the provisions of subdivisions (i), and (ii) of this subparagraph shall apply:

(i) Guards or barriers shall be erected as necessary to adjacent energized lines.

(ii) Upon completion of work on deenergized lines or equipment, each designated employee in charge shall determine that all employees in his crew are clear, that protective grounds installed by his crew have been removed, and he shall report to the designated authority that all tags protecting his crew may be removed.

(e) *Emergency procedures and first aid.* (1) The employer shall provide training or require that his employees are knowledgeable and proficient in:

(i) Procedures involving emergency situations, and

(ii) First-aid fundamentals including resuscitation.

(2) In lieu of paragraph (e)(1) of this section the employer may comply with the provisions of § 1926.50(c) regarding first-aid requirements.

(f) *Night work.* When working at night, spotlights or portable lights for emergency lighting shall be provided as needed to perform the work safely.

(g) *Work near and over water.* When crews are engaged in work over or near water and when danger of drowning exists, suitable protection shall be provided as stated in § 1926.104, or § 1926.105, or § 1926.106.

(h) *Sanitation facilities.* The requirements of § 1926.51 of Subpart D of this part shall be complied with for sanitation facilities.

(i) *Hydraulic fluids.* All hydraulic fluids used for the insulated sections of derrick trucks, aerial lifts, and hydraulic tools which are used on or around energized lines and equipment shall be of the insulating type. The requirements for fire resistant fluids of § 1926.302(d)(1) do not apply to hydraulic tools covered by this paragraph.

**§ 1926.951 Tools and protective equipment.**

(a) *Protective equipment.* (1)(i) Rubber protective equipment shall be in accordance with the provisions of the American National Standards Institute (ANSI), ANSI J6 series, as follows:

| *Item* | *Standard* |
|---|---|
| Rubber insulating gloves | J6.6-1971. |
| Rubber matting for use around electric apparatus. | J6.7-1935 (R1971). |
| Rubber insulating blankets | J6.4-1971. |
| Rubber insulating hoods | J6.2-1950 (R1971). |
| Rubber insulating line hose | J6.1-1950 (R1971). |
| Rubber insulating sleeves | J6.5-1971. |

(ii) Rubber protective equipment shall be visually inspected prior to use.

(iii) In addition, an "air" test shall be performed for rubber gloves prior to use.

(iv) Protective equipment of material other than rubber shall provide equal or better electrical and mechanical protection.

(2) Protective hats shall be in accordance with the provisions of ANSI Z89.2-1971 Industrial Protective Helmets for Electrical Workers, Class B, and shall be worn at the jobsite by employees who are exposed to the hazards of falling objects, electric shock, or burns.

(b) *Personal climbing equipment.* (1) Body belts with straps or lanyards shall be worn to protect employees working at elevated locations on poles, towers, or other structures except where such use creates a greater hazard to the safety of the employees, in which case other safeguards shall be employed.

(2) Body belts and safety straps shall meet the requirements of § 1926.959. In addition to being used as an employee safeguarding item, body belts with approved tool loops may be used for the purpose of holding tools. Body belts shall be free from additional metal hooks and tool loops other than those permitted in § 1926.959.

(3) Body belts and straps shall be inspected before use each day to determine that they are in safe working condition.

(4)(i) Life lines and lanyards shall comply with the provisions of § 1926.104.

(ii) Safety lines are not intended to be subjected to shock loading and are used for emergency rescue such as lowering a man to the ground. Such safety lines shall be a minimum of one-half-inch diameter and three or four strand first-grade manila or its equivalent in strength (2,650 lb.) and durability.

(5) Defective ropes shall be replaced.

(c) *Ladders.* (1) Portable metal or conductive ladders shall not be used near energized lines or equipment except as may be necessary in specialized work such as in high voltage substations where nonconductive ladders might present a greater hazard than conductive ladders. Conductive or metal ladders shall be prominently marked as conductive and all necessary precautions shall be taken when used in specialized work.

(2) Hook or other type ladders used in structures shall be positively secured to prevent the ladder from being accidentally displaced.

(d) *Live-line tools.* (1) Only live-line tool poles having a manufacturer's certification to withstand the following minimum tests shall be used:

(i) 100,000 volts per foot of length for 5 minutes when the tool is made of fiberglass; or

(ii) 75,000 volts per foot of length for 3 minutes when the tool is made of wood; or

(iii) Other tests equivalent to subdivision (i) or (ii) of this subparagraph as appropriate.

(2) All live-line tools shall be visually inspected before use each day. Tools to be used shall be wiped clean and if any hazardous defects are indicated such tools shall be removed from service.

(e) *Measuring tapes or measuring ropes.* Measuring tapes or measuring ropes which are metal or contain conductive strands shall not be used when working on or near energized parts.

(f) *Handtools.* (1) Switches for all powered hand tools shall comply with § 1926.300(d).

(2) All portable electric handtools shall:

(i) Be equipped with three-wire cord having the ground wire permanently connected to the tool frame and means for grounding the other end; or

(ii) Be of the double insulated type and permanently labeled as "Double Insulated"; or

(iii) Be connected to the power supply by means of an isolating transformer, or other isolated power supply.

(3) All hydraulic tools which are used on or around energized lines or equipment shall use nonconducting hoses having adequate strength for the normal operating pressures. It should be noted that the provisions of § 1926.302(d)(2) shall also apply.

(4) All pneumatic tools which are used on or around energized lines or equipment shall:

(i) Have nonconducting hoses having adequate strength for the normal operating pressures, and

(ii) Have an accumulator on the compressor to collect moisture.

**§ 1926.952 Mechanical equipment.**

(a) *General.* (1) Visual inspections shall be made of the equipment to determine that it is in good condition each day the equipment is to be used.

(2) Tests shall be made at the beginning of each shift during which the equipment is to be used to determine that the brakes and operating systems are in proper working condition.

(3) No employer shall use any motor vehicle equipment having an obstructed view to the rear unless:

(i) The vehicle has a reverse signal alarm audible above the surrounding noise level or;

(ii) The vehicle is backed up only when an observer signals that it is safe to do so.

(b) *Aerial lifts.* (1) The provisions of § 1926.556, Subpart N of this part, shall apply to the utilization of aerial lifts.

(2) When working near energized lines or equipment, aerial lift trucks shall be grounded or barricaded and considered as energized equipment, or the aerial lift truck shall be insulated for the work being performed.

(3) Equipment or material shall not be passed between a pole or structure and an aerial lift while an employee working from the basket is within reaching distance of energized conductors or equipment that are not covered with insulating protective equipment.

(c) *Derrick trucks, cranes and other lifting equipment.* (1) All derrick trucks, cranes and other lifting equipment shall comply with Subpart N and O of this part except:

(i) As stated in § 1926.550(a)(15) (i) and (ii) relating to clearance (for clearances in this subpart see Table V-1) and

(ii) Derrick truck (electric line trucks) shall not be required to comply with § 1926.550(a)(7)(vi), (a)(17), (b)(2), and (e).

(2) With the exception of equipment certified for work on the proper voltage, mechanical equipment shall not be operated closer to any energized line or equipment than the clearances set forth in § 1926.950(c) unless:

(i) An insulated barrier is installed between the energized part and the mechanical equipment, or

(ii) The mechanical equipment is grounded, or

(iii) The mechanical equipment is insulated, or

(iv) The mechanical equipment is considered as energized.

§ 1926.953 Material handling.

(a) *Unloading.* Prior to unloading steel, poles, cross arms and similar material, the load shall be thoroughly examined to ascertain if the load has shifted, binders or stakes have broken or the load is otherwise hazardous to employees.

(b) *Pole hauling.* (1) During pole hauling operations, all loads shall be secured to prevent displacement and a red flag shall be displayed at the trailing end of the longest pole.

(2) Precautions shall be exercised to prevent blocking of roadways or endangering other traffic.

(3) When hauling poles during the hours of darkness, illuminated warning devices shall be attached to the trailing end of the longest pole.

(c) *Storage.* (1) No materials or equipment shall be stored under energized bus, energized lines, or near energized equipment, if it is practical to store them elsewhere.

(2) When materials or equipment are stored under energized lines or near energized equipment, applicable clearances shall be maintained as stated in Table V-1; and extraordinary caution shall be exercised when moving materials near such energized equipment.

(d) *Tag line.* Where hazards to employees exist tag lines or other suitable devices shall be used to control loads being handled by hoisting equipment.

(e) *Oil filled equipment.* During construction or repair of oil filled equipment the oil may be stored in temporary containers other than those required in § 1926.152, such as pillow tanks.

(f) *Framing.* During framing operations, employees shall not work under a pole or a structure suspended by a crane, A-frame or similar equipment unless the pole or structure is adequately supported.

(g) *Attaching the load.* The hoist rope shall not be wrapped around the load. This provision shall not apply to electric construction crews when setting or removing poles.

§ 1926.954 Grounding for protection of employees.

(a) *General.* All conductors and equipment shall be treated as energized until tested or otherwise determined to be deenergized or until grounded.

(b) *New construction.* New lines or equipment may be considered deenergized and worked as such where:

(1) The lines or equipment are grounded, or

(2) The hazard of induced voltages is not present, and adequate clearances or other means are implemented to prevent contact with energized lines or equipment and the new lines or equipment.

(c) *Communication conductors.* Bare wire communication conductors on power poles or structures shall be treated as energized lines unless protected by insulating materials.

(d) *Voltage testing.* Deenergized conductors and equipment which are to be grounded shall be tested for voltage. Results of this voltage test shall determine the subsequent procedures as required in § 1926.950(d).

(e) *Attaching grounds.* (1) When attaching grounds, the ground end shall be attached first, and the other end shall be attached and removed by means of insulated tools or other suitable devices.

(2) When removing grounds, the grounding device shall first be removed from the line or equipment using insulating tools or other suitable devices.

(f) Grounds shall be placed between work location and all sources of energy and as close as practicable to the work location, or grounds shall be placed at the work location. If work is to be performed at more than one location in a line section, the line section must be grounded and short circuited at one location in the line section and the conductor to be worked on shall be grounded at each work location. The minimum distance shown in Table V-1 shall be maintained from ungrounded conductors at the work location. Where the making of a ground is impracticable, or the conditions resulting therefrom would be more hazardous than working on the lines or equipment without grounding, the grounds may be omitted and the line or equipment worked as energized.

(g) *Testing without grounds.* Grounds may be temporarily removed only when necessary for test purposes and extreme caution shall be exercised during the test procedures.

(h) *Grounding electrode.* When grounding electrodes are utilized, such electrodes shall have a resistance to ground low enough to remove the danger of harm to personnel or permit prompt operation of protective devices.

(i) *Grounding to tower.* Grounding to tower shall be made with a tower clamp capable of conducting the anticipated fault current.

(j) *Ground lead.* A ground lead, to be attached to either a tower ground or driven ground, shall be capable of conducting the anticipated fault current and shall have a minimum conductance of No. 2 AWG copper.

§ 1926.955 Overhead lines.

(a) *Overhead lines.* (1) When working on or with overhead lines the provisions of subparagraphs (2) through (8) of this section shall be complied with in addition to other applicable provisions of this subpart.

(2) Prior to climbing poles, ladders, scaffolds, or other elevated structures, an inspection shall be made to determine that the structures are capable of sustaining the additional or unbalanced stresses to which they will be subjected.

(3) Where poles or structures may be unsafe for climbing, they shall not be climbed until made safe by guying, bracing, or other adequate means.

(4) Before installing or removing wire or cable, strains to which poles and structures will be subjected shall be considered and necessary action taken to prevent failure of supporting structures.

(5)(i) When setting, moving, or removing poles using cranes, derricks, gin poles, A-frames, or other mechanized equipment near energized lines or equipment, precautions shall be taken to avoid contact with energized lines or equipment, except in barehand live-line work, or where barriers or protective devices are used.

(ii) Equipment and machinery operating adjacent to energized lines or equipment shall comply with § 1926.952(c)(2).

(6)(i) Unless using suitable protective equipment for the voltage involved, employees standing on the ground shall avoid contacting equipment or machinery working adjacent to energized lines or equipment.

(ii) Lifting equipment shall be bonded to an effective ground or it shall be considered energized and barricaded when utilized near energized equipment or lines.

(7) Pole holes shall not be left unattended or unguarded in areas where employees are currently working.

(8) Tag lines shall be of a nonconductive type when used near energized lines.

(b) *Metal tower construction.* (1) When working in unstable material the excavation for pad- or pile-type footings in excess of 5 feet deep shall be either sloped to the angle of repose as required in § 1926.652 or shored if entry is required. Ladders shall be provided for access to pad- or pile-type footing excavations in excess of 4 feet.

(2) When working in unstable material provision shall be made for cleaning out auger-type footings without requiring an employee to enter the footing unless shoring is used to protect the employee.

(3)(i) A designated employee shall be used in directing mobile equipment adjacent to footing excavations.

(ii) No one shall be permitted to remain in the footing while equipment is being spotted for placement.

(iii) Where necessary to assure the stability of mobile equipment the location of use for such equipment shall be graded and leveled.

(4)(i) Tower assembly shall be carried out with a minimum exposure of employees to falling objects when working at two or more levels on a tower.

(ii) Guy lines shall be used as necessary to maintain sections or parts of sections in position and to reduce the possibility of tipping.

(iii) Members and sections being assembled shall be adequately supported.

(5) When assembling and erecting towers the provisions of subdivisions (i), (ii) and (iii) of this subparagraph shall be complied with:

(i) The construction of transmission towers and the erecting of poles, hoisting machinery, site preparation machinery, and other types of construction machinery shall conform to the applicable requirements of this part.

(ii) No one shall be permitted under a tower which is in the process of erection or assembly, except as may be required to guide and secure the section being set.

(iii) When erecting towers using hoisting equipment adjacent to energized transmission lines, the lines shall be deenergized when practical. If the lines are not deenergized, extraordinary caution shall be exercised to maintain the minimum clearance distances required by § 1926.950(c), including Table V-1.

(6)(i) Erection cranes shall be set on firm level foundations and when the cranes are so equipped outriggers shall be used.

(ii) Tag lines shall be utilized to maintain control of tower sections being raised and positioned, except where the use of such lines would create a greater hazard.

(iii) The loadline shall not be detached from a tower section until the section is adequately secured.

(iv) Except during emergency restoration procedures erection shall be discontinued in the event of high wind or other adverse weather conditions which would make the work hazardous.

(v) Equipment and rigging shall be regularly inspected and maintained in safe operating condition.

(7) Adequate traffic control shall be maintained when crossing highways and railways with equipment as required by the provisions of § 1926.200(g) (1) and (2).

(8) A designated employee shall be utilized to determine that required clearance is maintained in moving equipment under or near energized lines.

(c) *Stringing or removing deenergized conductors.* (1) When stringing or removing deenergized conductors, the provisions of subparagraphs (2) through (12) of this paragraph shall be complied with.

(2) Prior to stringing operations a briefing shall be held setting forth the plan of operation and specifying the type of equipment to be used, grounding devices and procedures to be followed, crossover methods to be employed, and the clearance authorization required.

(3) Where there is a possibility of the conductor accidentally contacting an energized circuit or receiving a dangerous induced voltage buildup, to further protect the employee from the hazards of the conductor, the conductor being installed or removed shall be grounded or provisions made to insulate or isolate the employee.

(4)(i) If the existing line is deenergized, proper clearance authorization shall be secured and the line grounded on both sides of the crossover or, the line being strung or removed shall be considered and worked as energized.

(ii) When crossing over energized conductors in excess of 600 volts, rope nets or guard structures shall be installed unless provision is made to isolate or insulate the workman or the energized conductor. Where practical the automatic reclosing feature of the circuit interrupting device shall be made inoperative. In addition, the line being strung shall be grounded on either side of the crossover or considered and worked as energized.

(5) Conductors being strung in or removed shall be kept under positive control by the use of adequate tension reels, guard structures, tielines, or other means to prevent accidental contact with energized circuits.

(6) Guard structure members shall be sound and of adequate dimension and strength, and adequately supported.

(7)(i) Catch-off anchors, rigging, and hoists shall be of ample capacity to prevent loss of the lines.

(ii) The manufacturer's load rating shall not be exceeded for stringing lines, pulling lines, sock connections, and all load-bearing hardware and accessories.

(iii) Pulling lines and accessories shall be inspected regularly and replaced or repaired when damaged or when dependability is doubtful. The provisions of § 1926.251(c)(4)(ii) (concerning splices) shall not apply.

(8) Conductor grips shall not be used on wire rope unless designed for this application.

(9) While the conductor or pulling line is being pulled (in motion) employees shall not be permitted directly under overhead operations, nor shall any employee be permitted on the crossarm.

(10) A transmission clipping crew shall have a minimum of two structures clipped in between the crew and the conductor being sagged. When working on bare conductors, clipping and tying crews shall work between grounds at all times. The grounds shall remain intact until the conductors are clipped in, except on dead end structures.

(11)(i) Except during emergency restoration procedures, work from structures shall be discontinued when adverse weather (such as high wind or ice on structures) makes the work hazardous.

(ii) Stringing and clipping operations shall be discontinued during the progress of an electrical storm in the immediate vicinity.

(12)(i) Reel handling equipment, including pulling and braking machines, shall have ample capacity, operate smoothly, and be leveled and aligned in accordance with the manufacturer's operating instructions.

(ii) Reliable communications between the reel tender and pulling rig operator shall be provided.

(iii) Each pull shall be snubbed or dead ended at both ends before subsequent pulls.

(d) *Stringing adjacent to energized lines.* (1) Prior to stringing parallel to an existing energized transmission line a competent determination shall be made to ascertain whether dangerous induced voltage buildups will occur, particularly during switching and ground fault conditions. When there is a possibility that such dangerous induced voltage may exist the employer shall comply with the provisions of subparagraphs (2) through (9) of this paragraph in addition to the provisions of paragraph (c) of this § 1926.955, unless the line is worked as energized.

(2) When stringing adjacent to energized lines the tension stringing method or other methods which preclude unintentional contact between the lines being pulled and any employee shall be used.

(3) All pulling and tensioning equipment shall be isolated, insulated, or effectively grounded.

(4) A ground shall be installed between the tensioning reel setup and the first structure in order to ground each bare conductor, subconductor, and overhead ground conductor during stringing operations.

(5) During stringing operations, each bare conductor, subconductor, and overhead ground conductor shall be grounded at the first tower adjacent

to both the tensioning and pulling setup and in increments so that no point is more than 2 miles from a ground.

(i) The grounds shall be left in place until conductor installation is completed.

(ii) Such grounds shall be removed as the last phase of aerial cleanup.

(iii) Except for moving type grounds, the grounds shall be placed and removed with a hot stick.

(6) Conductors, subconductors, and overhead ground conductors shall be grounded at all dead-end or catch-off points.

(7) A ground shall be located at each side and within 10 feet of working areas where conductors, subconductors, or overhead ground conductors are being spliced at ground level. The two ends to be spliced shall be bonded to each other. It is recommended that splicing be carried out on either an insulated platform or on a conductive metallic grounding mat bonded to both grounds. When a grounding mat is used, it is recommended that the grounding mat be roped off and an insulated walkway provided for access to the mat.

(8)(i) All conductors, subconductors, and overhead ground conductors shall be bonded to the tower at any isolated tower where it may be necessary to complete work on the transmission line.

(ii) Work on dead-end towers shall require grounding on all deenergized lines.

(iii) Grounds may be removed as soon as the work is completed: *Provided,* That the line is not left open circuited at the isolated tower at which work is being completed.

(9) When performing work from the structures, clipping crews and all others working on conductors, subconductors, or overhead ground conductors shall be protected by individual grounds installed at every work location.

(e) *Live-line bare-hand work.* In addition to any other applicable standards contained elsewhere in this subpart all live-line bare-hand work shall be performed in accordance with the following requirements:

(1) Employees shall be instructed and trained in the live-line bare-hand technique and the safety requirements pertinent thereto before being permitted to use the technique on energized circuits.

(2) Before using the live-line bare-hand technique on energized high-voltage conductors or parts, a check shall be made of:

(i) The voltage rating of the circuit on which the work is to be performed;

(ii) The clearances to ground of lines and other energized parts on which work is to be performed; and

(iii) The voltage limitations of the aerial-lift equipment intended to be used.

(3) Only equipment designed, tested, and intended for live-line bare-hand work shall be used.

(4) All work shall be personally supervised by a person trained and qualified to perform live-line bare-hand work.

(5) The automatic reclosing feature of circuit interrupting devices shall be made inoperative where practical before working on any energized line or equipment.

(6) Work shall not be performed during the progress of an electrical storm in the immediate vicinity.

(7) A conductive bucket liner or other suitable conductive device shall be provided for bonding the insulated aerial device to the energized line or equipment.

(i) The employee shall be connected to the bucket liner by use of conductive shoes, leg clips, or other suitable means.

(ii) Where necessary, adequate electrostatic shielding for the voltage being worked or conductive clothing shall be provided.

(8) Only tools and equipment intended for live-line bare-hand work shall be used, and such tools and equipment shall be kept clean and dry.

(9) Before the boom is elevated, the outriggers on the aerial truck shall be extended and adjusted to stabilize the truck and the body of the truck shall be bonded to an effective ground, or barricaded and considered as energized equipment.

(10) Before moving the aerial lift into the work position, all controls (ground level and bucket) shall be checked and tested to determine that they are in proper working condition.

(11) Arm current tests shall be made before starting work each day, each time during the day when higher voltage is going to be worked and when changed conditions indicate a need for additional tests. Aerial buckets used for bare-hand live-line work shall be subjected to an arm current test. This test shall consist of placing the bucket in contact with an energized source equal to the voltage to be worked upon for a minimum time of three (3) minutes. The leakage current shall not exceed 1 microampere per kilo-volt of nominal line-to-line voltage. Work operations shall be suspended immediately upon any indication of a malfunction in the equipment.

(12) All aerial lifts to be used for live-line bare-hand work shall have dual controls (lower and upper) as required by subdivisions (i) and (ii) of this subparagraph.

(i) The upper controls shall be within easy reach of the employee in the basket. If a two basket type lift is used access to the controls shall be within easy reach from either basket.

(ii) The lower set of controls shall be located near base of the boom that will permit over-ride operation of equipment at any time.

(13) Ground level lift control shall not be operated unless permission has been obtained from the employee in lift, except in case of emergency.

(14) Before the employee contacts the energized part to be worked on, the conductive bucket liner shall be bonded to the energized conductor by means of a positive connection which shall remain attached to the energized conductor until the work on the energized circuit is completed.

(15) The minimum clearance distances for live-line bare-hand work shall be as specified in Table V-2. These minimum clearance distances shall be maintained from all grounded objects and from lines and equipment at a different potential than that to which the insulated aerial device is bonded unless such grounded objects or other lines and equipment are covered by insulated guards. These distances shall be maintained when approaching, leaving, and when bonded to the energized circuit.

TABLE V-2

MINIMUM CLEARANCE DISTANCES FOR LIVE-LINE BARE-HAND WORK (ALTERNATING CURRENT)

| Voltage range (phase-to-phase) kilovolts | Distance in feet and inches for maximum voltage | |
|---|---|---|
| | Phase to ground | Phase to phase |
| 2.1–15 | 2'0" | 2'0" |
| 15.1–35 | 2'4" | 2'4" |
| 35.1–46 | 2'6" | 2'6" |
| 46.1–72.5 | 3'0" | 3'0" |
| 72.6–121 | 3'4" | 4'6" |
| 138–145 | 3'6" | 5'0" |
| 161–169 | 3'8" | 5'6" |
| 230–242 | 5'0" | 8'4" |
| 345–362 | [1] 7'0" | [1] 13'4" |
| 500–552 | [1] 11'0" | [1] 20'0" |
| 700–765 | [1] 15'0" | [1] 31'0" |

[1] NOTE: For 345–362kv., 500–552kv., and 700–765kv., the minimum clearance distance may be reduced provided the distances are not made less than the shortest distance between the energized part and a grounded surface.

(16) When approaching, leaving, or bonding to an energized circuit the minimum distances in Table V-2 shall be maintained between all parts of the insulated boom assembly and any grounded parts (including the lower arm or portions of the truck).

(17) When positioning the bucket alongside an energized bushing or insulator string, the minimum line-to-ground clearances of Table V-2 must be maintained between all parts of the bucket and the grounded end of the bushing or insulator string.

(18)(i) The use of handlines between buckets, booms, and the ground is prohibited.

(ii) No conductive materials over 36 inches long shall be placed in the bucket, except for appropriate length jumpers, armor rods, and tools.

(iii) Nonconductive-type handlines may be used from line to ground when not supported from the bucket.

(19) The bucket and upper insulated boom shall not be overstressed by attempting to lift or support weights in excess of the manufacturer's rating.

(20)(i) A minimum clearance table (as shown in table V-2) shall be printed on a plate of durable nonconductive material, and mounted in the buckets or its vicinity so as to be visible to the operator of the boom.

(ii) It is recommended that insulated measuring sticks be used to verify clearance distances.

**§ 1926.956 Underground lines.**

(a) *Guarding and ventilating street opening used for access to underground lines or equipment.* (1) Appropriate warning signs shall be promptly placed when covers of manholes, handholes, or vaults are removed. What is an appropriate warning sign is dependent upon the nature and location of the hazards involved.

(2) Before an employee enters a street opening, such as a manhole or an unvented vault, it shall be promptly protected with a barrier, temporary cover, or other suitable guard.

(3) When work is to be performed in a manhole or unvented vault:

(i) No entry shall be permitted unless forced ventilation is provided or the atmosphere is found to be safe by testing for oxygen deficiency and the presence of explosive gases or fumes;

(ii) Where unsafe conditions are detected, by testing or other means, the work area shall be ventilated and otherwise made safe before entry;

(iii) Provisions shall be made for an adequate continuous supply of air.

(b) *Work in manholes.* (1) While work is being performed in manholes, an employee shall be available in the immediate vicinity to render emergency assistance as may be required. This shall not preclude the employee in the immediate vicinity from occasionally entering a manhole to provide assistance, other than emergency. This requirement does not preclude a qualified employee, working alone, from entering for brief periods of time, a manhole where energized cables or equipment are in service, for the purpose of inspection, housekeeping, taking readings, or similar work if such work can be performed safely.

(2) When open flames must be used or smoking is permitted in manholes, extra precautions shall be taken to provide adequate ventilation.

(3) Before using open flames in a manhole or excavation in an area where combustible gases or liquids may be present, such as near a gasoline service station, the atmosphere of the manhole or excavation shall be tested and found safe or cleared of the combustible gases or liquids.

(c) *Trenching and excavating.* (1) During excavation or trenching, in order to prevent the exposure of employees to the hazards created by damage to dangerous underground facilities, efforts shall be made to determine the location of such facilities and work conducted in a manner designed to avoid damage.

(2) Trenching and excavation operations shall comply with §§ 1926.651 and 1926.652.

(3) When underground facilities are exposed (electric, gas, water, telephone, etc.) they shall be protected as necessary to avoid damage.

(4) Where multiple cables exist in an excavation, cables other than the one being worked on shall be protected as necessary.

(5) When multiple cables exist in an excavation, the cable to be worked on shall be identified by electrical means unless its identity is obvious by reason of distinctive appearance.

(6) Before cutting into a cable or opening a splice, the cable shall be identified and verified to be the proper cable.

(7) When working on buried cable or on cable in manholes, metallic sheath continuity shall be maintained by bonding across the opening or by equivalent means.

**§ 1926.957 Construction in energized substations.**

(a) *Work near energized equipment facilities.* (1) When construction work is performed in an energized substation, authorization shall be obtained from the designated, authorized person before work is started.

(2) When work is to be done in an energized substation, the following shall be determined:

(i) What facilities are energized, and

(ii) What protective equipment and precautions are necessary for the safety of personnel.

(3) Extraordinary caution shall be exercised in the handling of busbars, tower steel, materials, and equipment in the vicinity of energized facilities. The requirements set forth in § 1926.950(c), shall be complied with.

(b) *Deenergized equipment or lines.* When it is necessary to deenergize equipment or lines for protection of employees, the requirements of § 1926.950(d) shall be complied with.

(c) *Barricades and barriers.* (1) Barricades or barriers shall be installed to prevent accidental contact with energized lines or equipment.

(2) Where appropriate, signs indicating the hazard shall be posted near the barricade or barrier. These signs shall comply with § 1926.200.

(d) *Control panels.* (1) Work on or adjacent to energized control panels shall be performed by designated employees.

(2) Precaution shall be taken to prevent accidental operation of relays or other protective devices due to jarring, vibration, or improper wiring.

(e) *Mechanized equipment.* (1) Use of vehicles, gin poles, cranes, and other equipment in restricted or hazardous areas shall at all times be controlled by designated employees.

(2) All mobile cranes and derricks shall be effectively grounded when being moved or operated in close proximity to energized lines or equipment, or the equipment shall be considered energized.

(3) Fenders shall not be required for lowboys used for transporting large electrical equipment, transformers, or breakers.

(f) *Storage.* The storage requirements of § 1926.953(c) shall be complied with.

(g) *Substation fences.* (1) When a substation fence must be expanded or removed for construction purposes, a temporary fence affording similar protection when the site is unattended, shall be provided. Adequate interconnection with ground shall be maintained between temporary fence and permanent fence.

(2) All gates to all unattended substations shall be locked, except when work is in progress.

(h) *Footing excavation.* (1) Excavation for auger, pad and piling type footings for structures and towers shall require the same precautions as for metal tower construction (see § 1926.955(b)(1)).

(2) No employee shall be permitted to enter an unsupported auger-type excavation in unstable material for any purpose. Necessary clean-out in such cases shall be accomplished without entry.

**§ 1926.958 External load helicopters.**

In all operations performed using a rotorcraft for moving or placing external loads, the provisions of § 1926.551 of Subpart N of this part shall be complied with.

**§ 1926.959 Lineman's body belts, safety straps, and lanyards.**

(a) *General requirements.* The requirements of paragraphs (a) and (b) of this section shall be complied with for all lineman's body belts, safety straps and lanyards acquired for use after the effective date of this subpart.

(1) Hardware for lineman's body belts, safety straps, and lanyards shall

be drop forged or pressed steel and have a corrosive resistive finish tested to American Society for Testing and Materials B117-64 (50-hour test). Surfaces shall be smooth and free of sharp edges.

(2) All buckles shall withstand a 2,000-pound tensile test with a maximum permanent deformation no greater than one sixty-fourth inch.

(3) D rings shall withstand a 5,000-pound tensile test without failure. Failure of a D ring shall be considered cracking or breaking.

(4) Snaphooks shall withstand a 5,000-pound tensile test without failure. Failure of a snaphook shall be distortion sufficient to release the keeper.

(b) *Specific requirements.* (1)(i) All fabric used for safety straps shall withstand an A.C. dielectric test of not less than 25,000 volts per foot "dry" for 3 minutes, without visible deterioration.

(ii) All fabric and leather used shall be tested for leakage current and shall not exceed 1 milliampere when a potention of 3,000 volts is applied to the electrodes positioned 12 inches apart.

(iii) Direct current tests may be permitted in lieu of alternating current tests.

(2) The cushion part of the body belt shall:

(i) Contain no exposed rivets on the inside;

(ii) Be at least three (3) inches in width;

(iii) Be at least five thirty-seconds (5/32) inch thick, if made of leather; and

(iv) Have pocket tabs that extended at least 1½ inches down and three (3) inches back of the inside of circle of each D ring for riveting on plier or tool pockets. On shifting D belts, this measurement for pocket tabs shall be taken when the D ring section is centered.

(3) A maximum of four (4) tool loops shall be so situated on the body belt that four (4) inches of the body belt in the center of the back, measuring from D ring to D ring, shall be free of tool loops, and any other attachments.

(4) Suitable copper, steel, or equivalent liners shall be used around bar of D rings to prevent wear between these members and the leather or fabric enclosing them.

(5) All stitching shall be of a minimum 42-pound weight nylon or equivalent thread and shall be lock stitched. Stitching parallel to an edge shall not be less than three-sixteenths (3/16) inch from edge of narrowest member caught by the thread. The use of cross stitching on leather is prohibited.

(6) The keeper of snaphooks shall have a spring tension that will not allow the keeper to begin to open with a weight of 2½ pounds or less, but the keeper of snaphooks shall begin to open with a weight of four (4) pounds, when the weight is supported on the keeper against the end of the nose.

(7) Testing of lineman's safety straps, body belts and lanyards shall be in accordance with the following procedure:

(i) Attach one end of the safety strap or lanyard to a rigid support, the other end shall be attached to a 250-pound canvas bag of sand:

(ii) Allow the 250-pound canvas bag of sand to free fall 4 feet for (safety strap test) and 6 feet for (lanyard test); in each case stopping the fall of the 250-pound bag:

(iii) Failure of the strap or lanyard shall be indicated by any breakage, or slippage sufficient to permit the bag to fall free of the strap or lanyard. The entire "body belt assembly" shall be tested using one D ring. A safety strap or lanyard shall be used that is capable of passing the "impact loading test" and attached as required in subdivision (i) of this subparagraph. The body belt shall be secured to the 250-pound bag of sand at a point to simulate the waist of a man and allowed to drop as stated in subdivision (ii) of this subparagraph. Failure of the body belt shall be indicated by any breakage, or slippage sufficient to permit the bag to fall free of the body belt.

**§ 1926.960 Definitions applicable to this subpart.**

(a) *Alive or live (energized).* The term means electrically connected to a source of potential difference, or electrically charged so as to have a potential significantly different from that of the earth in the vicinity. The term "live" is sometimes used in place of the term "current-carrying," where the intent is clear, to avoid repetition of the longer term.

(b) *Automatic circuit recloser.* The term means a self-controlled device for automatically interrupting and reclosing an alternating current circuit with a predetermined sequence of opening and reclosing followed by resetting, hold closed, or lockout operation.

(c) *Barrier.* The term means a physical obstruction which is intended to prevent contact with energized lines or equipment.

(d) *Barricade.* The term means a physical obstruction such as tapes, screens, or cones intended to warn and limit access to a hazardous area.

(e) *Bond.* The term means an electrical connection from one conductive element to another for the purpose of minimizing potential differences or providing suitable conductivity for fault current or for mitigation of leakage current and electrolytic action.

(f) *Bushing.* The term means an insulating structure including a through conductor, or providing a passageway for such a conductor, with provision for mounting on a barrier, conducting or otherwise, for the purpose of insulating the conductor from the barrier and conducting current from one side of the barrier to the other.

(g) *Cable.* The term means a conductor with insulation, or a stranded conductor with or without insulation and other coverings (single-conductor cable) or a combination of conductors insulated from one another (multiple-conductor cable).

(h) *Cable sheath.* The term means a protective covering applied to cables.

NOTE: A cable sheath may consist of multiple layers of which one or more is conductive.

(i) *Circuit.* The term means a conductor or system of conductors through which an electric current is intended to flow.

(j) *Communication lines.* The term means the conductors and their supporting or containing structures which are used for public or private signal or communication service, and which operate at potentials not exceeding 400 volts to ground or 750 volts between any two points of the circuit, and the transmitted power of which does not exceed 150 watts. When operating at less than 150 volts no limit is placed on the capacity of the system.

NOTE: Telephone, telegraph, railroad signal, data, clock, fire, police-alarm, community television antenna, and other systems conforming with the above are included. Lines used for signaling purposes, but not included under the above definition, are considered as supply lines of the same voltage and are to be so run.

(k) *Conductor.* The term means a material, usually in the form of a wire, cable, or bus bar suitable for carrying an electric current.

(l) *Conductor shielding.* The term means an envelope which encloses the conductor of a cable and provides an equipotential surface in contact with the cable insulation.

(m) *Current-carrying part.* The term means a conducting part intended to be connected in an electric circuit to a source of voltage. Non-current-carrying parts are those not intended to be so connected.

(n) *Dead (deenergized).* The term means free from any electrical connection to a source of potential difference and from electrical charges: Not having a potential difference from that of earth.

NOTE: The term is used only with reference to current-carrying parts which are sometimes alive (energized).

(o) *Designated employee.* The term means a qualified person delegated to perform specific duties under the conditions existing.

(p) *Effectively grounded.* The term means intentionally connected to earth through a ground connection or connections of sufficiently low impedance and having sufficient current-carrying capacity to prevent the buildup of voltages which may result in undue hazard to connected equipment or to persons.

(q) *Electric line trucks.* The term means a truck used to transport men, tools, and material, and to serve as a traveling workshop for electric power line construction and maintenance work. It is sometimes equipped with a boom and auxiliary equipment for setting poles, digging holes, and elevating material or men.

(r) *Enclosed.* The term means surrounded by a case, cage, or fence, which will protect the contained equipment and prevent accidental contact of a person with live parts.

(s) *Equipment.* This is a general term which includes fittings, devices, appliances, fixtures, apparatus, and the like, used as part of, or in connection with, an electrical power transmission and distribution system, or communication systems.

(t) *Exposed.* The term means not isolated or guarded.

(u) *Electric supply lines.* The term means those conductors used to transmit electric energy and their necessary supporting or containing structures. Signal lines of more than 400 volts to ground are always supply lines within the meaning of the rules, and those of less than 400 volts to ground may be considered as supply lines, if so run and operated throughout.

(v) *Guarded.* The term means protected by personnel, covered, fenced, or enclosed by means of suitable casings, barrier rails, screens, mats, platforms, or other suitable devices in accordance with standard barricading techniques designed to prevent dangerous approach or contact by persons or objects.

NOTE: Wires, which are insulated but not otherwise protected, are not considered as guarded.

(w) *Ground. (Reference).* The term means that conductive body, usually earth, to which an electric potential is referenced.

(x) *Ground (as a noun).* The term means a conductive connection whether intentional or accidental, by which an electric circuit or equipment is connected to reference ground.

(y) *Ground (as a verb).* The term means the connecting or establishment of a connection, whether by intention or accident of an electric circuit or equipment to reference ground.

(z) *Grounding electrode (ground electrode).* The term grounding electrode means a conductor embedded in the earth, used for maintaining ground potential on conductors connected to it, and for dissipating into the earth current conducted to it.

(aa) *Grounding electrode resistance.* The term means the resistance of the grounding electrode to earth.

(bb) *Grounding electrode conductor (grounding conductor).* The term means a conductor used to connect equipment or the grounded circuit of a wiring system to a grounding electrode.

(cc) *Grounded conductor.* The term means a system or circuit conductor which is intentionally grounded.

(dd) *Grounded system.* The term means a system of conductors in which at least one conductor or point (usually the middle wire, or neutral point of transformer or generator windings) is intentionally grounded, either solidly or through a current-limiting device (not a current-interrupting device).

(ee) *Hotline tools and ropes.* The term means those tools and ropes which are especially designed for work on energized high voltage lines and equipment. Insulated aerial equipment especially designed for work on energized high voltage lines and equipment shall be considered hot line.

(ff) *Insulated.* The term means separated from other conducting surfaces by a dielectric substance (including air space) offering a high resistance to the passage of current.

NOTE: When any object is said to be insulated, it is understood to be insulated in suitable manner for the conditions to which it is subjected. Otherwise, it is within the purpose of this subpart, uninsulated. Insulating covering of conductors is one means of making the conductor insulated.

(gg) *Insulation (as applied to cable).* The term means that which is relied upon to insulate the conductor from other conductors or conducting parts or from ground.

(hh) *Insulation shielding.* The term means an envelope which encloses the insulation of a cable and provides an equipotential surface in contact with cable insulation.

(ii) *Isolated.* The term means an object that is not readily accessible to persons unless special means of access are used.

(jj) *Manhole.* The term means a subsurface enclosure which personnel may enter and which is used for the purpose of installing, operating, and maintaining equipment and/or cable.

(kk) *Pulling tension.* The term means the longitudinal force exerted on a cable during installation.

(ll) *Qualified person.* The term means a person who by reason of experience or training is familiar with the operation to be performed and the hazards involved.

(mm) *Switch.* The term means a device for opening and closing or changing the connection of a circuit. In these rules, a switch is understood to be manually operable, unless otherwise stated.

(nn) *Tag.* The term means a system or method of identifying circuits, systems or equipment for the purpose of alerting persons that the circuit, system or equipment is being worked on.

(oo) *Unstable material.* The term means earth material, other than running, that because of its nature or the influence of related conditions, cannot be depended upon to remain in place without extra support, such as would be furnished by a system of shoring.

(pp) *Vault.* The term means an enclosure above or below ground which personnel may enter and is used for the purpose of installing, operating, and/or maintaining equipment and/or cable.

(qq) *Voltage.* The term means the effective (rms) potential difference between any two conductors or between a conductor and ground. Voltages are expressed in nominal values. The nominal voltage of a system or circuit is the value assigned to a system or circuit of a given voltage class for the purpose of convenient designation. The operating voltage of the system may vary above or below this value.

(rr) *Voltage of an effectively grounded circuit.* The term means the voltage between any conductor and ground unless otherwise indicated.

(ss) *Voltage of a circuit not effectively grounded.* The term means the voltage between any two conductors. If one circuit is directly connected to and supplied from another circuit of higher voltage (as in the case of an autotransformer), both are considered as of the higher voltage, unless the circuit of lower voltage is effectively grounded, in which case its voltage is not determined by the circuit of higher voltage. Direct connection implies electric connection as distinguished from connection merely through electromagnetic or electrostatic induction.

## Subpart W—Rollover Protective Structures; Overhead Protection

Sec.

1926.1000 Rollover protective structures (ROPS) for material handling equipment.
1926.1001 Minimum performance criteria for rollover protective structures for designated scrapers, loaders, dozers, graders, and crawler tractors.
1926.1002 Protective frame (ROPS) test procedures and performance requirements for wheel-type agricultural and industrial tractors used in construction.
1926.1003 Overhead protection for operators of agricultural and industrial tractors.

**§ 1926.1000 Rollover protective structures (ROPS) for material handling equipment.**

(a) *Coverage.* (1) This section applies to the following types of material handling equipment: To all rubber-tired, self-propelled scrapers, rubber-tired front-end loaders, rubber-tired dozers, wheel-type agricultural and industrial tractors, crawler tractors, crawler-type loaders, and motor graders, with or without attachments, that are used in construction work. This requirement does not apply to sideboom pipelaying tractors.

(2) The promulgation of specific standards for rollover protective structures for compactors and rubber-tired skid-steer equipment is reserved pending consideraton of standards currently being developed.

(b) *Equipment manufactured on or after September 1, 1972.* Material handling machinery described in paragraph (a) of this section and manufactured on or after September 1, 1972, shall be equipped with rollover protective structures which meet the minimum performance standards prescribed in §§ 1926.1001 and 1926.1002, as applicable.

(c) *Equipment manufactured before September 1, 1972.* (1) All material handling equipment described in paragraph (a) of this section and manufactured or placed in service (owned or operated by the employer) prior to September 1, 1972, shall be fitted with rollover protective structures no later than the dates listed below:

(i) Machines manufactured on or after January 1, 1972, shall be fitted no later than April 1, 1973.

(ii) Machines manufactured between July 1, 1971, and December 31, 1971, shall be fitted no later than July 1, 1973.

(iii) Machines manufactured between July 1, 1970, and June 30, 1971, shall be fitted no later than January 1, 1974.

(iv) Machines manufactured between July 1, 1969, and June 30, 1970, shall be fitted no later than July 1, 1974.

(v) Machines manufactured before July 1, 1969: Reserved pending further study, development, and review.

(2) Rollover protective structures and supporting attachment shall meet the minimum performance criteria detailed in §§ 1926.1001 and 1926.1002, as applicable or shall be designed, fabricated, and installed in a manner which will support, based on the ultimate strength of the metal, at least two times the weight of the prime mover applied at the point of impact.

(i) The design objective shall be to minimize the likelihood of a complete overturn and thereby minimize the possibility of the operator being crushed as a result of a rollover or upset.

(ii) The design shall provide a vertical clearance of at least 52 inches from the work deck to the ROPS at the point of ingress or egress.

(d) *Remounting.* ROPS removed for any reason, shall be remounted with equal quality, or better, bolts or welding as required for the original mounting.

(e) *Labeling.* Each ROPS shall have the following information permanently affixed to the structure:

(1) Manufacturer or fabricator's name and address;

(2) ROPS model number, if any;

(3) Machine make, model, or series number that the structure is designed to fit.

(f) *Machines meeting certain existing governmental requirements.* Any machine in use, equipped with rollover protective structures, shall be deemed in compliance with this section if it meets the rollover protective structure requirements of the State of California, the U.S. Army Corps of Engineers, or the Bureau of Reclamation of the U.S. Department of the Interior in effect on April 5, 1972. The requirements in effect are:

(1) State of California: Construction Safety Orders, issued by the Department of Industrial Relations pursuant to Division 5, Labor Code, § 6312, State of California.

(2) U.S. Army Corps of Engineers: General Safety Requirements, EM-385-1-1 (March 1967).

(3) Bureau of Reclamation, U.S. Department of the Interior: Safety and Health Regulations for Construction. Part II (September 1971).

**§ 1926.1001 Minimum performance criteria for rollover protective structures for designated scrapers, loaders, dozers, graders, and crawler tractors.**

(a) *General.* This section prescribes minimum performance criteria for rollover protective structures (ROPS) for rubber-tired self-propelled scrapers; rubber-tired front-end loaders and rubber-tired dozers; crawler tractors, and crawler-type loaders, and motor graders. The vehicle and ROPS as a system shall have the structural characteristics prescribed in paragraph (f) of this section for each type of machine described in this paragraph.

(b) The static laboratory test prescribed herein will determine the adequacy of the structures used to protect the operator under the following conditions:

(1) For rubber-tired self-propelled scrapers, rubber-tired front-end loaders, and rubber-tired dozers: Operating between 0 and 10 miles per hour over hard clay where rollover would be limited to a maximum roll angle of 360° down a slope of 30° maximum.

(2) For motor graders: Operating between 0 and 10 miles per hour over hard clay where rollover would be limited to 360° down a slope of 30° maximum.

(3) For crawler tractors and crawler-type loaders: Operating between 0 and 10 miles per hour over hard clay where rollover would be limited to a maximum roll angle of 360° down a slope of 45°.

(c) *Facilities and apparatus.* (1) The following material is necessary:

(i) Material, equipment, and tiedown means adequate to insure that the ROPS and its vehicle frame absorb the applied energy.

(ii) Equipment necessary to measure and apply loads to the ROPS. Adequate means to measure deflections and lengths should also be provided.

(iii) Recommended, but not mandatory, types of test setups are illustrated in Figure W-1 for all types of equipment to which this section applies; and in Figure W-2 for rubber-tired self-propelled scrapers; Figure W-3 for rubber-tired front-end loaders, rubber-tired dozers, and motor graders; and Figure W-4 for crawler tractors and crawler-type loaders.

(2) Table W-1 contains a listing of the required apparatus for all types of equipment described in paragraph (a) of this section.

TABLE W-1

| *Means to measure* | *Accuracy* |
|---|---|
| Deflection of ROPS, inches. | ±5% of deflection measured. |
| Vehicle weight, pounds. | ±5% of the weight measured. |
| Force applied to frame, pounds. | ±5% of force measured. |
| Dimensions of critical zone, inches. | ±0.5 in. |

(d) *Vehicle condition.* The ROPS to be tested must be attached to the vehicle structure in the same manner as it will be attached during vehicle use. A totally assembled vehicle is not required. However, the vehicle structure and frame which support the ROPS must represent the actual vehicle installation. All normally detachable windows, panels, or nonstructural fittings shall be removed so that they do not contribute to the strength of the ROPS.

(e) *Test procedure.* The test procedure shall include the following, in the sequence indicated:

(1) Energy absorbing capabilities of ROPS shall be verified when loaded laterally by incrementally applying a distributed load to the longitudinal outside top member of the ROPS, as shown in Figure W-1, W-2, or W-3, as applicable. The distributed load must be applied so as to result in approximately uniform deflection of the ROPS. The load increments should correspond with approximately 0.5 in. ROPS deflection increment in the direction of the load application, meas-

ured at the ROPS top edge. Should the operator's seat be offcenter, the load shall be applied on the offcenter side. For each applied load increment, the total load (lb.) versus corresponding deflection (in.) shall be plotted, and the area under the load-deflection curve shall be calculated. This area is equal to the energy (in.-lb.) absorbed by the ROPS. For a typical load-deflection curve and calculation method, see Figure W-5.

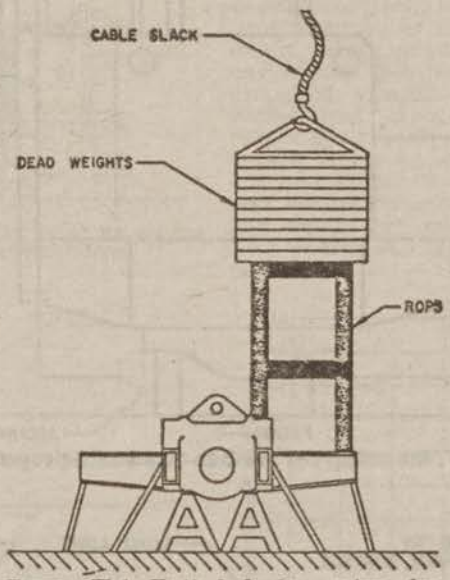



FIGURE W-1—Vertical loading setup for all types of equipment described in § 1518.1001(a).

Incremental loading shall be continued until the ROPS has absorbed the amount of energy and the minimum applied load specified under paragraph (f) of this section has been reached or surpassed.

[4510-26-C]

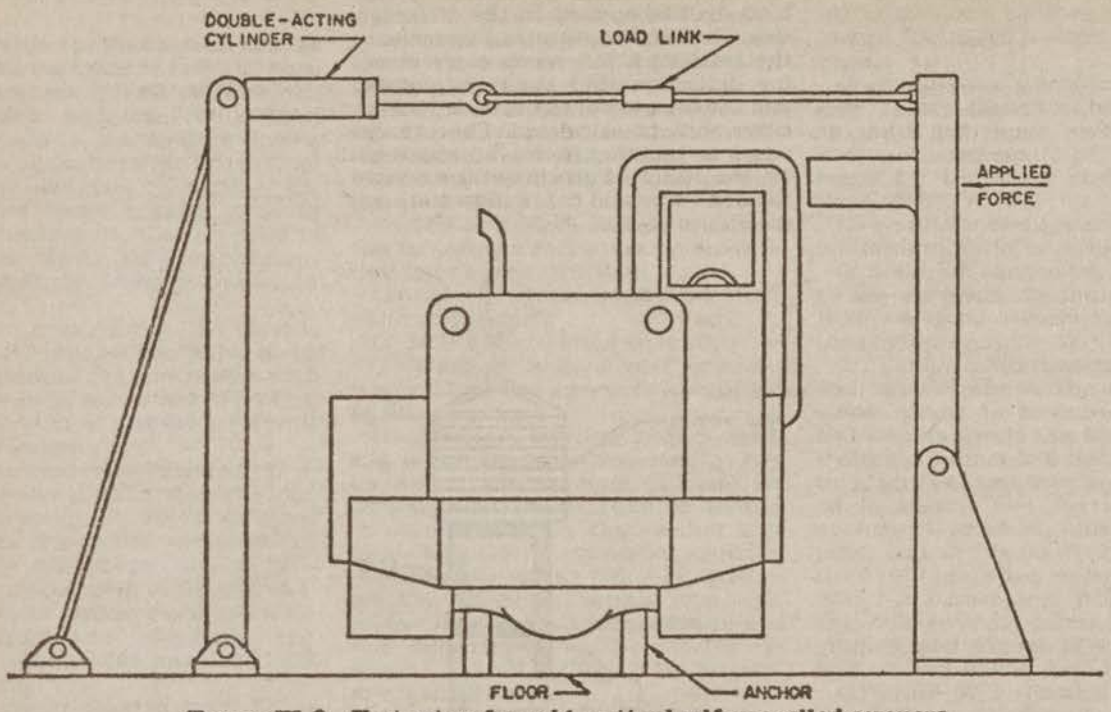



FIGURE W-2—Test setup for rubber-tired self-propelled scrapers.

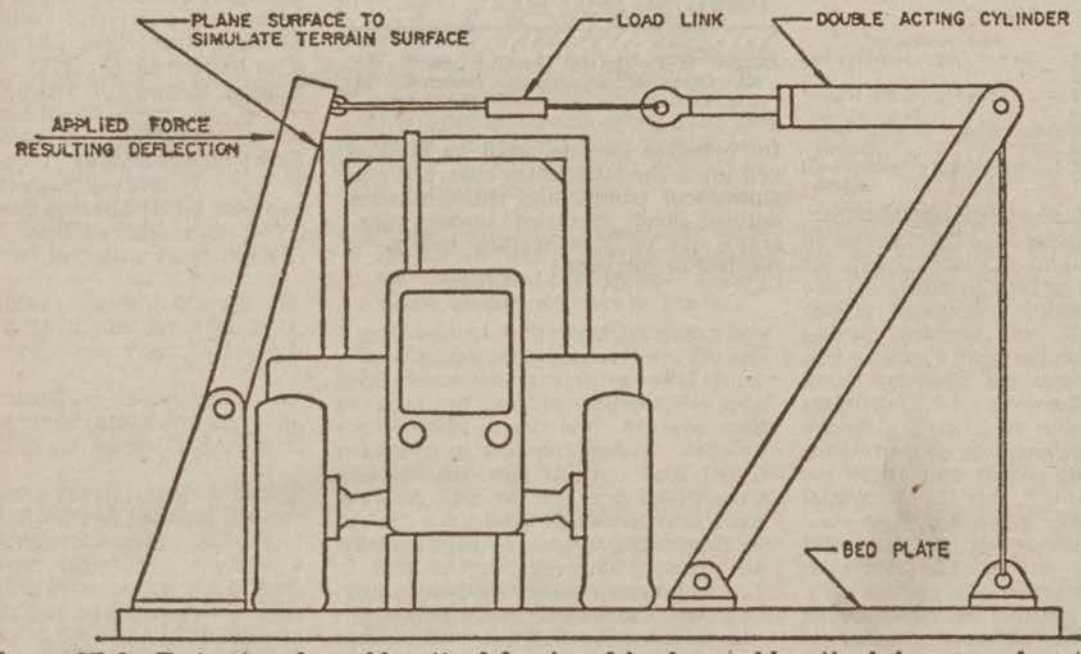



FIGURE W-3—Test setup for rubber-tired front-end loaders, rubber-tired dozers, and motor graders.

(2) To cover the possibility of the vehicle coming to rest on its top, the support capability shall be verified by applying a distributed vertical load to the top of the ROPS so as to result in approximately uniform deflection (see Figure W-1). The load magnitude is specified in paragraph (f)(2)(iii) of this section.

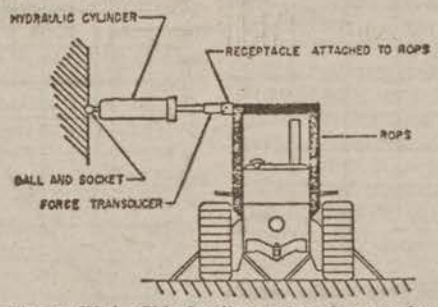
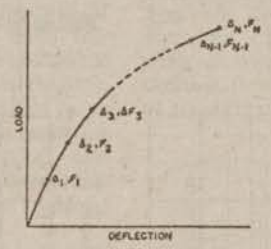



FIGURE W-4—Side-loading setup for crawler tractors and crawler loaders.




Δ-TOTAL DEFLECTION
F-FORCE APPLIED

$$\text{AREA} = \frac{\Delta_1 F_1}{2} + (\Delta_2 - \Delta_1)\frac{F_1 + F_2}{2} + (\Delta_3 - \Delta_2)\frac{F_2 + F_3}{2} + \cdots + (\Delta_N - \Delta_{N-1})\frac{F_{N-1} + F_N}{2}$$

FIGURE W-5—Determination of energy area under force deflection curve for all types of ROPS equipment defined in § 1926.1001.

(3) The low temperature impact strength of the material used in the ROPS shall be verified by suitable material tests or material certification (see paragraph (f)(2)(iv) of this section).

(f) *Performance requirements*—(1) *General performance requirements.* (i) No repairs or straightening of any member shall be carried out between each prescribed test.

(ii) During each test, no part of the ROPS shall enter the critical zone as detailed in SAE J397 (1969). Deformation of the ROPS shall not allow the plane of the ground to enter this zone.

(2) *Specific performance requirements.* (i) The energy requirement for purposes of meeting the requirements of paragraph (e)(1) of this section is to be determined by referring to the plot of the energy versus weight of vehicle (see Figure W-6 for rubber-tired self-propelled scrapers; Figure W-7 for rubber-tired front-end loaders and rubber-tired dozers; Figure W-8 for crawler tractors and crawler-type loaders; and Figure W-9 for motor graders). For purposes of this section, force and weight are measured as pounds (lb.); energy (U) is measured as inch-pounds.

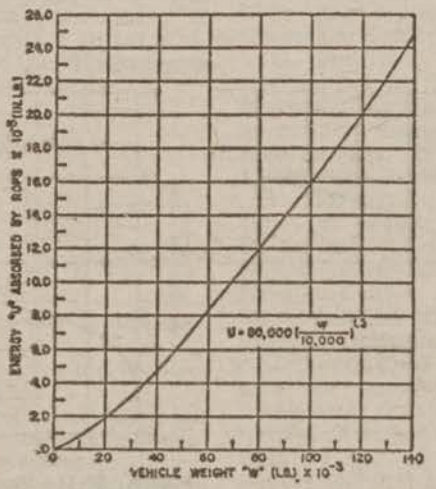



FIGURE W-6—Energy absorbed versus vehicle weight.

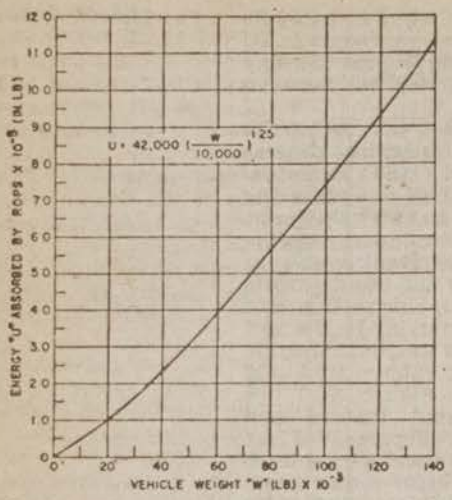



FIGURE W-7—Energy absorbed versus vehicle weight.

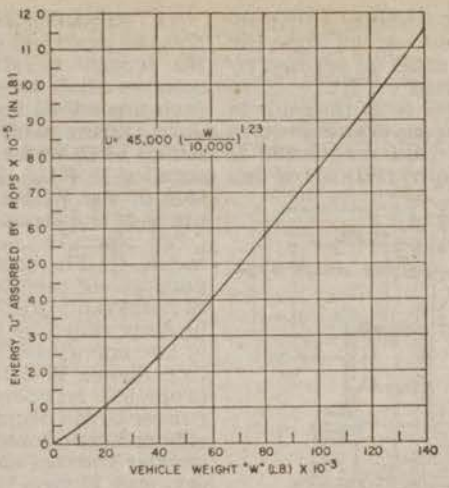



FIGURE W-8—Energy absorbed versus vehicle weight.

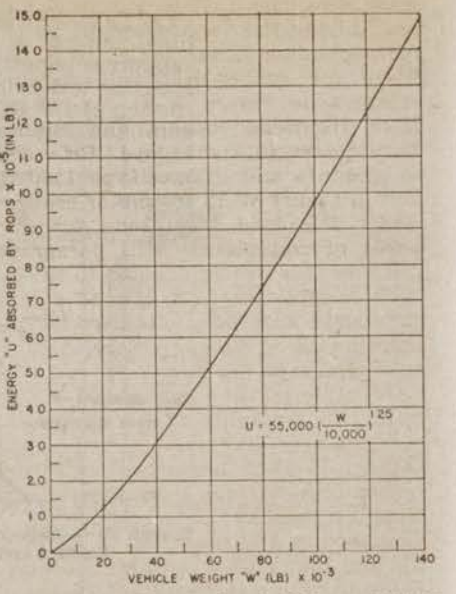



FIGURE W-9—Energy absorbed Versus Vehicle Weight.

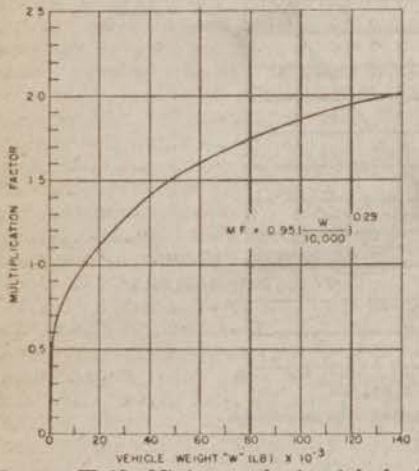



FIGURE W-10—Minimum horizontal load factor for self-propelled scrapers.

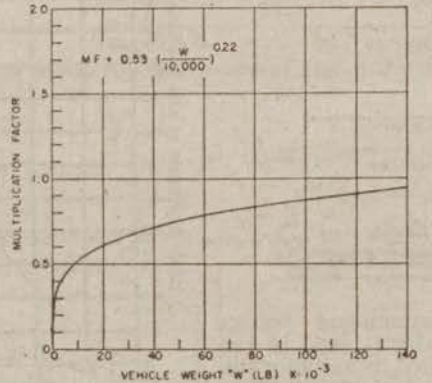



FIGURE W-11—Minimum horizontal load factor for rubber-tired loaders and dozers.

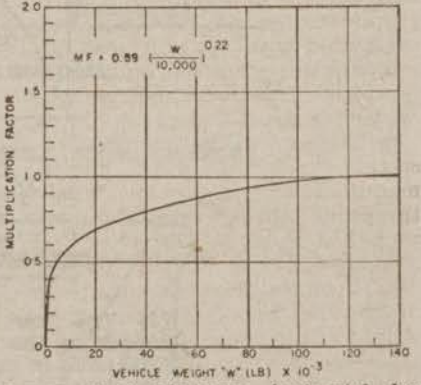



FIGURE W-12—Minimum horizontal load factor for crawler tractors and crawler-type loaders.

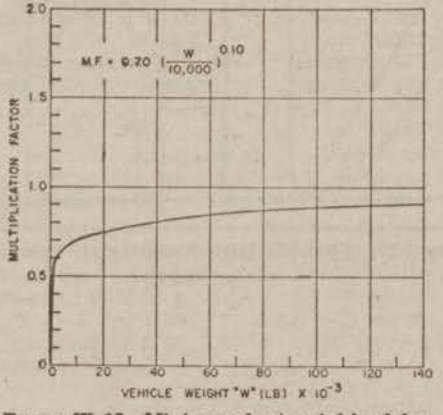



FIGURE W-13—Minimum horizontal load factor for motor graders.

(ii) The applied load must attain at least a value which is determined by multiplying the vehicle weight by the corresponding factor shown in Figure W-10 for rubber-tired self-propelled scrapers; in Figure W-11 for rubber-tired front-end loaders and rubber-tired dozers; in Figure W-12 for crawler tractors and crawler-type loaders; and in Figure W-13 for motor graders.

(iii) The load magnitude for purposes of compliance with paragraph (e)(2) of this section is equal to the vehicle weight. The test of load magnitude shall only be made after the requirements of subparagraph (2)(i) of this paragraph are met.

(iv) Material used in the ROPS must have the capability of performing at zero degrees Fahrenheit, or exhibit Charpy V notch impact strength of 8 foot-pounds at minus 20° Fahrenheit. This is a standard Charpy specimen as described in American Society of Testing and Materials A 370, Methods and Definitions for Mechanical Testing of Steel Products (available at each Regional Office of the Occupational Safety and Health Administration). The purpose of this requirement is to reduce the tendency of brittle fracture associated with dynamic loading, low temperature operation, and stress raisers which cannot be entirely avoided on welded structures.

(g) *Definitions.* For purposes of this section, "vehicle weight" means the manufacturer's maximum weight of the prime mover for rubber-tired self-propelled scrapers. For other types of equipment to which this section applies, "vehicle weight" means the manufacturer's maximum recommended weight of the vehicle plus the heaviest attachment.

(h) *Source of standard.* This standard is derived from, and restates, the following Society of Automotive Engineers Recommended Practices: SAE J320a, Minimum Performance Criteria for Roll-Over Protective Structure for Rubber-Tired, Self-Propelled Scrapers; SAE J394, Minimum Performance Criteria for Roll-Over Protective Structure for Rubber-Tired Front End Loaders and Rubber-Tired Dozers; SAE J395, Minimum Performance Criteria for Roll-Over Protective Structure for Crawler Tractors and Crawler-Type Loaders; and SAE J396, Minimum Performance Criteria for Roll-Over Protective Structure for Motor Graders. These recommended practices shall be resorted to in the event that questions of interpretation arise. The recommended practices appear in the 1971 SAE Handbook, which may be examined in each of the Regional Offices of the Occupational Safety and Health Administration.

**§ 1926.1002 Protective frame (ROPS) test procedures and performance requirements for wheel-type agricultural and industrial tractors used in construction.**

(a) *General.* (1) The purpose of this section is to set forth requirements for frames for the protection of operators of wheel type agricultural and industrial tractors to minimize the possibility of operator injury resulting from accidental upsets during normal operation. With respect to agricultural and industrial tractors, the provisions of §§ 1926.1001 and 1926.1003 for rubber-tired dozers and rubber-tired loaders may be utilized in lieu of the requirements of this section.

(2) The protective frame which is the subject of this standard is a structure mounted to the tractor that extends above the operator's seat and conforms generally to Figure W-14.

(3) If an overhead weather shield is attached to the protective frame, it may be in place during tests: *Provided,* That it does not contribute to the strength of the protective frame. If such an overhead weather shield is attached, it must meet the requirements of paragraph (i) of this section.

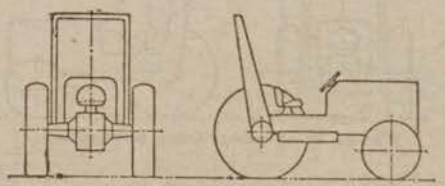


FIGURE W-14—Typical frame configuration.

(4) For overhead protection requirements, see § 1926.1003.

(5) If protective enclosures are used on wheel-type agricultural and industrial tractors, they shall meet the requirements of Society of Automotive Engineers Standard J168 (July 1970), Protective Enclosures, Test Procedures, and Performance Requirements. This standard appears in the 1971 SAE Handbook and may be examined in each Regional Office of the Occupational Safety and Health Administration.

(b) *Applicability.* The requirements of this section apply to wheel-type agricultural tractors used in construction work and to wheel-type industrial tractors used in construction work. See paragraph (j) of this section for definitions of agricultural tractors and industrial tractors.

(c) *Performance requirements.* (1) Either a laboratory test or a field test is required in order to determine the performance requirements set forth in subdivision (i) of this subparagraph.

(2) A laboratory test may be either static or dynamic. The laboratory test must be under conditions of repeatable and controlled loading in order to permit analysis of the protective frame.

(3) A field upset test, if used, shall be conducted under reasonably controlled conditions, both rearward and sideways to verify the effectiveness of the protective frame under actual dynamic conditions.

(d) *Test procedures—general.* (1) The tractor used shall be the tractor with the greatest weight on which the protective frame is to be used.

(2) A new protective frame and mounting connections of the same design shall be used for each test procedure.

(3) Instantaneous and permanent frame deformation shall be measured and recorded for each segment of the test.

(4) Dimensions relative to the seat shall be determined with the seat unloaded and adjusted to its highest and most rearward latched position provided for a seated operator.

(5) If the seat is offset, the frame loading shall be on the side with the least space between the centerline of the seat and the upright.

(6) The low temperature impact strength of the material used in the protective structure shall be verified by suitable material tests or material certifications in accordance with § 1926.1001 (f)(2)(iv).

(e) *Test procedure for vehicle overturn—(1) Vehicle weight.* The weight of the tractor, for purposes of this section, includes the protective frame, all fuels, and other components required for normal use of the tractor. Ballast must be added if necessary to achieve a minimum total weight of 130 lb. (59 kg.) per maximum power takeoff horsepower at rated engine speed. The weight of the front end must be at least 33 lb. (15 kg.) per maximum power takeoff horsepower. In case power takeoff horsepower is unavailable, 95 percent of net engine flywheel horsepower shall be used.

(2) Agricultural tractors shall be tested at the weight set forth in subparagraph (1) of this paragraph.

(3) Industrial tractors shall be tested with items of integral or mounted equipment and ballast that are sold as standard equipment or approved by the vehicle manufacturer for use with the vehicle where the protective frame is expected to provide protection for the operator with such equipment installed. The total vehicle weight and front end weight as tested shall not be less than the weights established in subparagraph (1) of this paragraph.

(4) The test shall be conducted on a dry, firm soil bank as illustrated in Figure W-15. The soil in the impact area shall have an average cone index in the 0-6 in. (153 mm.) layer not less than 150 according to American Society of Agricultural Engineers Recom-

mendation ASAE R313, Soil Cone Penetrometer (available in each Regional Office of the Occupational Safety and Health Administration). The path of travel of the vehicle shall be 12°±2° to the top edge of the bank.

(5) The upper edge of the bank shall be equipped with an 18 in. (457 mm.) high ramp as described in Figure W-15 to assist in tipping the vehicle.

(6) The front and rear wheel tread settings, where adjustable, shall be at the position nearest to halfway between the minimum and maximum settings obtainable on the vehicle. Where only two settings are obtainable, the minimum setting shall be used.

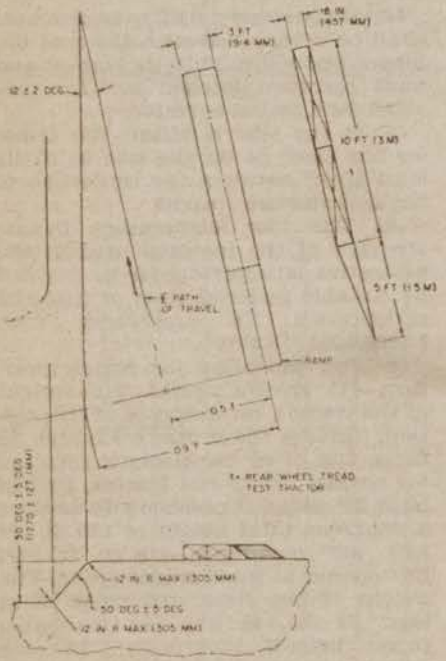


FIGURE W-15.

(7) *Vehicle Overturn Test—Sideways and Rearward.* (i) The tractor shall be driven under its own power along the specified path of travel at a minimum speed of 10 m.p.h. (16 km./hr.) or maximum vehicle speed if under 10 m.p.h. (16 km./hr.) up the ramp as described in subparagraph (5) of this paragraph to induce sideways overturn.

(ii) Rear upset shall be induced by engine power with the tractor operating in gear to obtain 3-5 m.p.h. (4.8-8 km./hr.) at maximum governed engine r.p.m. preferably by driving forward directly up a minimum slope of two vertical to one horizontal. The engine clutch may be used to aid in inducing the upset.

(f) *Other test procedures.* When the field upset test is not used to determine ROPS performance, either the static test or the dynamic test, contained in paragraph (g) or (h) of this section, shall be made.

(g) *Static test—(1) Test conditions.* (i) The laboratory mounting base shall include that part of the tractor chassis to which the protective frame is attached including the mounting parts.

(ii) The protective frame shall be instrumented with the necessary equipment to obtain the required load deflection data at the locations and directions specified in Figures W-16, W-17, and W-18.

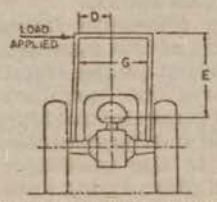



FIGURE W-16—Side load application.

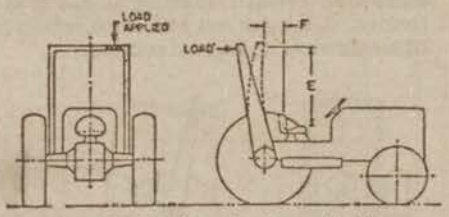



FIGURE W-17—Rear load application.

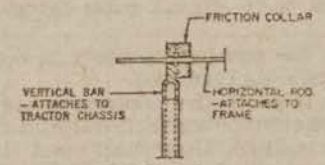



FIGURE W-18—Method of measuring instantaneous deflection.

(iii) The protective frame and mounting connections shall be instrumented with the necessary recording equipment to obtain the required load-deflection data to be used in calculating FSB (see paragraph (j)(3) of this section). The gauges shall be placed on mounting connections before the installation load is applied.

(2) *Test procedure.* (i) The side load application shall be at the upper extremity of the frame upright at a 90° angle to the centerline of the vehicle. The side load "L" shall be applied according to Figure W-16. "L" and "D" shall be recorded simultaneously. The test shall be stopped when:

(A) The strain energy absorbed by the frame is equal to the required input energy ($E_{is}$) or

(B) Deflection of the frame exceeds the allowable deflection, or

(C) The frame load limit occurs before the allowable deflection is reached in the side load.

(ii) The L-D diagram, as shown by means of a typical example in Figure W-19, shall be constructed, using the data obtained in accordance with subdivision (i) of this subparagraph.

(iii) The modified $L_m$-$D_m$ diagram shall be constructed according to subdivision (ii) of this subparagraph and according to Figure W-20. The strain energy absorbed by the frame ($E_u$) shall then be determined.

(iv) $E_{is}$, FER, and FSB shall be calculated.

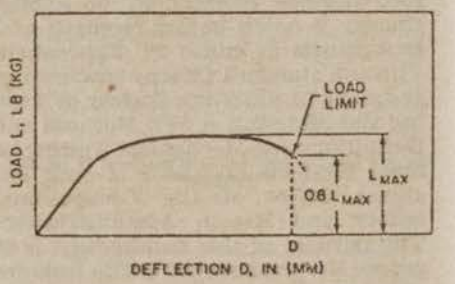



FIGURE W-19—Typical L-D diagram.

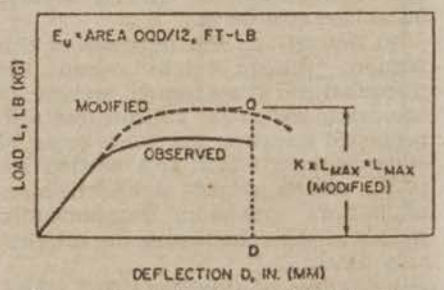



FIGURE W-20—Typical modified $L_m$-$D_m$ diagram.

(v) The test procedure shall be repeated on the same frame utilizing L (rear input; see FIGURE W-18) and $E_{ir}$. Rear load application shall be uniformly distributed along a maximum projected dimension of 27 in. (686 mm.) and a maximum area of 160 sq. in. (1,032 sq. cm.) normal to the direction of load application. The load shall be applied to the upper extremity of the frame at the point which is midway between the centerline of the seat and the inside of the frame upright.

(h) *Dynamic test—(1) Test conditions.* (i) The protective frame and tractor shall meet the requirements of paragraphs (e)(2) or (3) of this section, as appropriate.

(ii) The dynamic loading shall be produced by use of a 4,410 lb. (2,000 kg.) weight acting as a pendulum. The impact face of the weight shall be 27 plus or minus 1 in. by 27 plus or minus 1 in. (686+ or −25 mm.) and shall be constructed so that its center of gravity is within 1 in. (25.4 mm.) of its geometric center. The weight shall be suspended from a pivot point 18-22 ft. (5.5-6.7 m.) above the point of impact on the frame and shall be conveniently and safely adjustable for height. (See Figure W-21.)

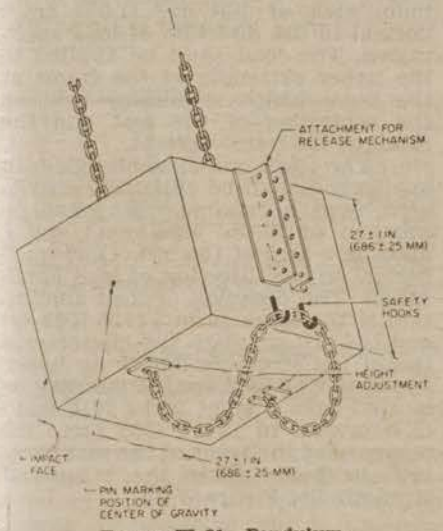



FIGURE W-21—Pendulum.

(iii) For each phase of testing, the tractor shall be restrained from moving when the dynamic load is applied. The restraining members shall be of 0.5-0.63 in. (12.5-16 mm.) steel cable and points of attaching restraining members shall be located an appropriate distance behind the rear axle and in front of the front axle to provide a 15°-30° angle between a restraining cable and the horizontal. The restraining member shall either be in the plane in which the center gravity of the pendulum will swing or more than one restraining cable shall give a resultant force in this plane. (See Figure W-22.)

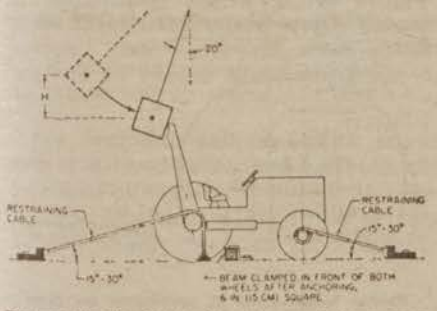



FIGURE W-22—Method of impact from rear

(iv) The wheel tread setting shall comply with the requirements of paragraph (e)(6) of this section. The tires shall have no liquid ballast and shall be inflated to the maximum operating pressure recommended by the tire manufacturer. With specified tire inflation, the restraining cables shall be tightened to provide tire deflection of 6-8 percent of nominal tire section width. After the vehicle is properly restrained, a wooden beam 6 × 6 in. (15 × 15 cm.) shall be driven tightly against the appropriate wheels and clamped. For the test to the side, an additional wooden beam shall be placed as a prop against the wheel nearest the operator's station and shall be secured to the floor so that it is held tightly against the wheel rim during impact. The length of this beam shall be chosen so that when it is positioned against the wheel rim, it is at an angle of 25°-40° to the horizontal. It shall have a length 20-25 times its depth and a width two to three times its depth. (See Figures W-22 and W-23.)

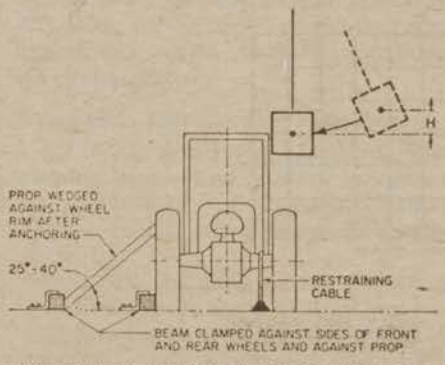



FIGURE W-23—Method of impact from side.

(v) Means shall be provided indicating the maximum instantaneous deflection along the line of impact. A simple friction device is illustrated in Figure W-23.

(vi) No repair or adjustments may be carried out during the test.

(vii) If any cables, props, or blocking shift or break during the test, the test shall be repeated.

(2) *Test procedure*—(i) *General.* The frame shall be evaluated by imposing dynamic loading to rear followed by a load to the side on the same frame. The pendulum dropped from the height (see definition "H" in paragraph (j)(3) of this section) imposes the dynamic load. The position of the pendulum shall be so selected that the initial point of impact on the frame shall be in line with the arc of travel of the center of gravity of the pendulum. A quick release mechanism should be used but, if used, shall not influence the attitude of the block.

(ii) *Impact at rear.* The tractor shall be properly restrained according to subparagraphs (1) (iii) and (iv) of this paragraph. The tractor shall be positioned with respect to the pivot point of the pendulum such that the pendulum is 20° from the vertical prior to impact, as shown in Figure W-22. The impact shall be applied to the upper extremity of the frame at the point which is midway between the centerline of the seat and the inside of the frame upright of a new frame.

(iii) *Impact at side.* The block and restraining shall conform to subparagraphs (1) (iii) and (iv) of this paragraph. The point of impact shall be that structural member of the protective frame likely to hit the ground first in a sideways accidental upset. The side impact shall be applied to the side opposite that used for rear impact.

(i) *Performance requirements*—(1) *General.* (i) The frame, overhead weather shield, fenders, or other parts in the operator area may be deformed but shall not shatter or leave sharp edges exposed to the operator, or violate dimensions as shown in Figures W-16 and W-17 as follows:

D=2 in. (51 mm.) inside of frame upright to vertical centerline of seat.
E=30 in. (762 mm.).
F=Not less than 0 in. and not more than 12 in. (305 mm.), measured at centerline front of seat backrest to crossbar along the line of load application as shown in Figure W-17.
G=24 in. (610 mm.).

(ii) The material and design combination used in the protective structure must be such that the structure can meet all prescribed performance tests at zero degrees Fahrenheit in accordance with § 1926.1001(f)(2)(iv).

(2) *Vehicle overturn performance requirements.* The requirements of this paragraph (i) must be met in both side and rear overturns.

(3) *Static test performance requirements.* Design factors shall be incorporated in each design to withstand an overturn test as prescribed in this paragraph (i). The structural requirements will be generally met if FER is greater than 1 and FSB is greater than K-1 in both side and rear loadings.

(4) *Dynamic test performance requirements.* Design factors shall be incorporated in each design to withstand the overturn test prescribed in this paragraph (i). The structural requirements will be generally met if the dimensions in this paragraph (i) are adhered to in both side and rear loads.

(j) *Definitions applicable to this section.* (1) SAE J333a, Operator Protection for Wheel-Type Agricultural and Industrial Tractors (July 1970) defines "agricultural tractor" as a "wheel-type vehicle of more than 20 engine horse-

power designed to furnish the power to pull, carry, propel, or drive implements that are designed for agricultural usage." Since this Part 1926 applies only to construction work, the following definition of "agricultural tractor" is adopted for purposes of this subpart: "Agricultural tractor" means a wheel-type vehicle of more than 20 engine horsepower, used in construction work, which is designed to furnish the power to pull, propel, or drive implements.

(2) "Industrial tractor" means that class of wheeled type tractor of more than 20 engine horsepower (other than rubber-tired loaders and dozers described in § 1926.1001), used in operations such as landscaping, construction services, loading, digging, grounds keeping, and highway maintenance.

(3) The following symbols, terms, and explanations apply to this section:

$E_{ib}$=Energy imput to be absorbed during side loading. $E_{ib}=723+0.4$ W ft.-lb. ($E'_{ib}=100+0.12W'$, m.-kg.).

$E_{ir}$=Energy input to be absorbed during rear loading. $E_{ir}=0.47$ W ft.-lb. ($E'_{ir}=0.14$ W', m.-kg.).

W=Tractor weight as prescribed in § 1926.1002 (e)(1) and (e)(3), in lb. (W', kg.).

L=Static load, lb. (kg.).

D=Deflection under L, in. (mm.).

L-D=Static load-deflection diagram.

$L_m$-$D_m$=Modified static load-deflection diagram (Figure W-20). To account for increase in strength due to increase in strain rate, raise L in plastic range to L×K.

K=Increase in yield strength induced by higher rate of loading (1.3 for hot rolled low carbon steel 1010-1030). Low carbon is preferable; however, if higher carbon or other material is used, K must be determined in the laboratory. Refer to Charles H. Norris, et al., Structural Design for Dynamic Loads (1959), p.3.

$L_{max}$=Maximum observed static load.

Load Limit=Point on L-D curve where observed static load is 0.8 $L_{max}$ (refer to Figure W-19).

$E_u$=Strain energy absorbed by the frame, ft.-lb. (m.-kg.) area under $L_m$-$D_m$ curve.

FER=Factor of energy ratio, $FER=E_u/E_{ib}$; also $=E_u/E_{ir}$.

$P_b$=Maximum observed force in mounting connection under static load, L, lb. (kg.).

FSB=Design margin for mounting connection $FSB=(P_u/P_b)-1$.

H=Vertical height of lift of 4,410 lb. (2,000 kg.) weight, in. (H', mm.). The weight shall be pulled back so that the height of its center of gravity above the point of impact is defined as follows: $H=4.92+0.00190$ W or ($H'=125+0.107$ W') (Figure W-24).

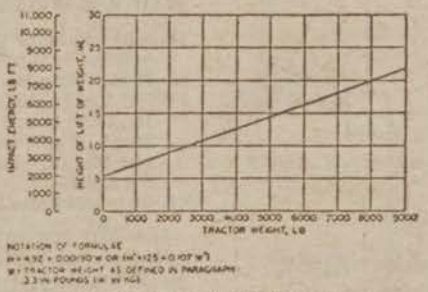



FIGURE W-24—Impact energy and corresponding lift height of 4,410 lb. (2,000 kg.) weight.

(k) *Source of standard.* The standard in this section is derived from, and restates, Society of Automotive Engineers Standard J334a (July 1970), Protective Frame Test Procedures and Performance Requirements. This standard shall be resorted to in the event that questions of interpretation arise. The standard appears in the 1971 SAE Handbook, which may be examined in each of the Regional Offices of the Occupational Safety and Health Administration.

**§ 1926.1003 Overhead protection for operators of agricultural and industrial tractors.**

(a) *General*—(1) *Purpose.* When overhead protection is provided on wheel-type agricultural and industrial tractors, the overhead protection shall be designed and installed according to the requirements contained in this section. The provisions of § 1926.1001 for rubber-tired dozers and rubber-tired loaders may be used in lieu of the standards contained in this section. The purpose of the standard is to minimize the possibility of operator injury resulting from overhead hazards such as flying and falling objects, and at the same time to minimize the possibility of operator injury from the cover itself in the event of accidental upset.

(2) *Applicability.* This standard applies to wheel-type agricultural tractors used in construction work and to wheel-type industrial tractors used in construction work. See § 1926.1002 (b) and (j). In the case of machines to which § 1926.604 (relating to site clearing) also applies, the overhead protection may be either the type of protection provided in § 1926.604 or the type of protection provided by this section.

(b) *Overhead protection.* When overhead protection is installed on wheel-type agricultural or industrial tractors used in construction work, it shall meet the requirements of this paragraph. The overhead protection may be constructed of a solid material. If grid or mesh is used, the largest permissible opening shall be such that the maximum circle which can be inscribed between the elements of the grid or mesh is 1.5 in. (38 mm.) in diameter. The overhead protection shall not be installed in such a way as to become a hazard in the case of upset.

(c) *Test procedures—general.* (1) The requirements of § 1926.1002 (d), (e), and (f) shall be met.

(2) Static and dynamic rear load application shall be uniformly distributed along a maximum projected dimension of 27 in. (686 mm.) and a maximum area of 160 in.$^2$ (1,032 cm.$^2$) normal to the direction of load application. The load shall be applied to the upper extremity of the frame at the point which is midway between the centerline of the seat and the inside of the frame upright.

(3) The static and dynamic side load application shall be uniformly distributed along a maximum projected dimension of 27 in. (686 mm.) and a maximum area of 160 in.$^2$ (1,032 cm.$^2$) normal to the direction of load application. The direction of load application is the same as in § 1926.1002 (g) and (h). To simulate the characteristics of the structure during an upset, the center of load application may be located from a point 24 in. (610 mm.) (K) forward to 12 in. (305 mm.) (L) rearward of the front of the seat backrest to best utilize the structural strength. See Figure W-25.

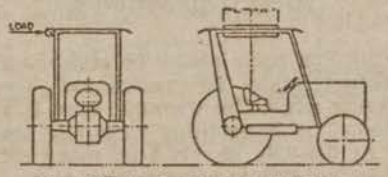



FIGURE W-25—Location for side load.

(d) *Drop test procedures.* (1) The same frame shall be subjected to the drop test following either the static or dynamic test.

(2) A solid steel sphere or material of equivalent spherical dimension weighing 100 lb. (45.4 kg.) shall be dropped once from a height 10 ft. (3,048 mm.) above the overhead cover.

(3) The point of impact shall be on the overhead cover at a point within the zone of protection as shown in Figure W-26, which is furthest removed from major structural members.

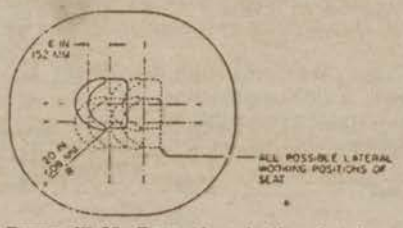



FIGURE W-26—Zone of protection for drop test.

(e) *Crush test procedure.* (1) The same frame shall be subjected to the crush test following the drop test and static or dynamic test.

(2) The test load shall be applied as shown in Figure W-27 with the seat positioned as specified in § 1926.1002(d)(4). Loading cylinders shall be pivotally mounted at both ends. Loads applied by each cylinder shall be equal within 2 percent, and the sum of the loads of the two cylinders shall be two times the tractor weight as set forth in § 1926.1002(e)(1). The maximum width of the beam illustrated in Figure W-27 shall be 6 in. (152 mm.).

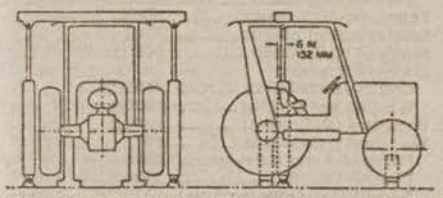



FIGURE W-27—Method of load application for crush test.

(f) *Performance requirements*—(1) *General.* The performance requirements set forth in § 1926.1002(i) (2), (3), and (4) shall be met.

(2) *Drop test performance requirements.* (i) Instantaneous deformation due to impact of the sphere shall not enter the protected zone as illustrated in Figures W-25, W-26, and W-28.

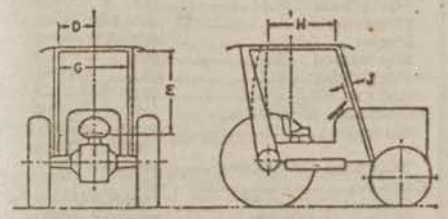



FIGURE W-28—Protected zone during crush and drop tests.

(ii) In addition to the dimensions set forth in § 1926.1002(i)(1)(i), the following dimensions apply to Figure W-28:

H=17.5 in. (444 mm.)
J=2 in. (50.8 mm.) measured from the outer periphery of the steering wheel.

(3) *Crush test performance requirements.* The protected zone as described in Figure W-28 must not be violated.

(g) *Source of standard.* This standard is derived from, and restates, the portions of Society of Automotive Engineers Standard J167 which pertain to overhead protection requirements. The full title of the SAE standard is: Protective Frame with Overhead Protection—Test Procedures and Performance Requirements. The SAE standard shall be resorted to in the event that questions of interpretation arise. The SAE standard appears in the 1971 SAE Handbook, which may be examined in each of the Regional Offices of the Occupational Safety and Health Administration.

### Subpart X—Effective Dates

Sec.
1926.1050 Effective dates (general).
1926.1051 Effective dates (specific).

## Subpart X—Effective Dates

### § 1926.1050 Effective dates (general).

Except where different effective dates are specifically provided in § 1926.1051, the safety and health standards published in Subparts C through U of this part shall become effective on April 24, 1971, for all Federal and federally assisted advertised contracts subject thereto which are advertised after that date and on April 27, 1971, for all such negotiated contracts for which negotiations begin after that date.

### § 1926.1051 Effective dates (specific).

(a) With respect to standards concerning brakes and fenders prescribed in § 1926.602, the rules contained therein specify the applicable effective dates.

(b)(1) To the extent that the standards in this part apply to light residential construction, their application is delayed until September 27, 1971, whereupon the standards shall apply to contracts subject to the Contract Work Hours and Safety Standards Act which are advertised on or after that date and to such contracts which may be negotiated when the negotiations commence on or after that date.

(2) For the purpose of this paragraph, the term "light residential construction" is limited to the construction of homes and apartments which do not exceed three stories in height, and which do not have an elevator.

SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION

SUBJECT INDEX FOR 29 CFR PART 1926


| Subject term | Section No. |
|---|---|
| A | |
| Abrasive Wheels and Tools | .303. |
| Accident Prevention Responsibilities | .20(b). |


SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION—Continued

SUBJECT INDEX FOR 29 CFR PART 1926


| Subject term | Section No. |
|---|---|
| Act (Definition) | .32(a). |
| Administrative Adjudications | .4. |
| Aerial Lifts | .952(b), .556, .955(e)(10)-(12). |
| Boom Platforms | .556(b)(2). |
| Bursting Safety Factor | .556(b)(4). |
| Electrical Tests | .556(b)(3). |
| Field Modifications | .556(a)(2). |
| Ladder Trucks | .556(b)(1). |
| Tower Trucks | .556(b)(1). |
| Requirements: | |
| General | .556(a). |
| Specific | .556(b). |
| Welding Standards | .556(b)(5). |
| Air Quality | .800(c)(1). |
| Alarms, Fire | .150(e). |
| Alarms, Audible | .602(a)(9). |
| Alive (Definition) | .960(a). |
| Angle of Repose | .651. |
| Definition | .653. |
| Pile Driving | .603(c)(3). |
| Table P-1 (Approximate Angle of Repose) | .652. |
| Approved (Definition) | .32(e). |
| LP Gas Equipment | .153 (d), (f), (h). |
| Arc Welding and Cutting | .351. |
| Asbestos Dust | .55. |
| Atomic Energy Commission | .53. |
| Audible Warning | .601(b)(3). |
| Authorized Person (Definition) | .32(d). |
| Automatic Circuit Recloser (Definition) | .960(b). |
| B | |
| Barges: | |
| Access | .605(b). |
| First Aid and Lifesaving Equipment | .605(d). |
| Mobile Cranes | .550(f). |
| Pile Driving | .603(b). |
| Working Surfaces | .605(c). |
| Barricades | .202. |
| Cranes | .550(a)(9). |
| Definition | .203(a), 960(c). |
| Excavations | .651(s). |
| Motor Vehicle Equipment | .600(a). |
| Barrier (Definition) | .960(c). |
| Battery Rooms and Charging | .403 |
| Belts, Safety | .104. |
| Definition | .107(f). |
| Materials Storage | .250(b)(2). |
| Pile Driving | .603(a)(8). |
| Scaffolding | .451. |
| Steel Erection | .752(k). |
| Tunnels and Shafts | .800(h)(3)(v). |
| Blasting | .900. |
| Agents, Storage | .904. |
| Blaster Qualifications | .901. |
| Electric | .906. |
| Excavation Work | .913. |
| Firing | .909. |
| Loading | .905. |
| Tunnels and Shafts | .800(j). |
| Underwater | .912 |
| Blocking, Blocks: | |
| Jacks | .305(c). |
| Motor Vehicles | .600(a)(3). |
| Pile-Driving Equipment | .603(a). |
| Tunnels and Shafts | .800(k). |
| Boatswain's Chair Scaffolds | .451(l). |
| Body Belts | .556(b)(2) (iii), (v); .959. |
| (see Body Belts, Safety Straps and Lanyards) | |
| Cushion Parts | .959(b)(2) (i)-(iv). |
| Tool Loops | .959(b)(3). |
| Body Belts, Safety Straps and Lanyards | .959. |
| Buckles | .959(a)(2). |
| D Rings | .959(a)(3). |
| Liners | .959(b)(4). |

SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION—Continued
SUBJECT INDEX FOR 29 CFR PART 1926


| Subject term | Section No. |
|---|---|
| Hardware | .959(a)(1). |
| Snap Hooks | .959(a)(4). |
| Keepers | .959(b)(6). |
| Stitching | .959(b)(5). |
| Testing | .959(b)(1), (7). |
| Boilers | .29(b). |
| Pile-Driving Equipment | .603(a). |
| Bolting, Bolts | .752(b). |
| Rock | .800(h)(2). |
| Bond (Definition) | .960(e). |
| Boom Platforms | .556(b)(2). |
| Brackets, Roofing | .451(u). |
| Brakes: | |
| Earthmoving Equipment | .602(a)(4). |
| Equipment | .600, .602. |
| Motor Vehicles | .601. |
| Bricklayers' Square Scaffolds | .451(n). |
| Buckets, Concrete | .700(d)(7). |
| Buggies, Concrete | .700(d)(5). |
| Buildings, Temporary | .151(b). |
| Bulkheads, Compressed Air | .803(m). |
| Bullfloats | .700(d)(3). |
| Bushing (Definition) | .960(f). |
| C | |
| Cable Sheath (Definition) | .960(h). |
| Cables: | |
| Definition | .960(g). |
| Flexible Cables and Cords | .402(a). |
| Trailing Cables | .402(a) (6), (7). |
| Trenching Cables | .956(c)(4-7). |
| Welding Cables and Connectors | .351(b). |
| Caissons | .801. |
| Carbon Tetrachloride | .150(c)(1)(viii). |
| Cargo Hooks | .551(d). |
| Carpenters' Bracket Scaffolds | .451(m). |
| Certifications: | |
| Boilers | .29(b). |
| Diesel Equipment, Underground | .800(c)(2)(vii). |
| Pressure Vessels | .29(a). |
| Chains, Alloy Steel | .251(b)(1). |
| Chimneys, Removal | .854. |
| Chutes: | |
| Demolition | .852. |
| Waste Disposal | .252. |
| Circuit (Definition) | .960(i). |
| Circuit Recloser, Automatic (Definition) | .960(b). |
| Circuits, Lockout and Tagging | .400(g). |
| Circuit, Voltage of | .960 (rr), (ss). |
| Clearing, Clearances: | |
| Cranes and Derricks | .550(a)(15)(iv), .950(c), .955(b)(8). |
| Fire Prevention | .151 (c), (d). |
| Materials Storage | .250. |
| Site | .604. |
| Temporary Heating Devices | .154. |
| Workspace | .400(e). |
| Climbing Equipment | .951(b). |
| Body Belts | .951(b) (1)-(3). |
| Lifelines | .951(b)(4)(i). |
| Lanyards | .951(b)(2), (4)(i); .959. |
| Ropes | .951(b)(5). |
| Safety Lines | .951(b)(4)(ii). |
| Straps, Safety | .951(b) (1)-(3). |
| Closed Container (Definition) | .155(b). |
| Clothing (see Personal Protective Equipment) | |
| Cofferdams | .802. |
| Combustion (Definition) | .155(d). |
| Communication Lines (Definition) | .960(j). |
| Competent Person (Definition) | .32(f). |
| Compressed Air | .803. |
| Excavations | .913. |
| Pneumatic Power Tools | .302(b)(4). |
| Compression | .803(e). |
| Compressor Plants | .803(h). |
| Concrete and Concrete Forms | .700. |
| Conductor (Definition) | .960(k). |
| Conductor, Grounded (Definition) | .960(cc). |
| Conductor, Grounding (Definition) | .960(bb). |
| Conductor Shielding (Definition) | .960(l). |
| Conductors, Deenergized | .955(c). |
| Conductors, Wire | .954(c). |
| Confined Spaces: | |
| General Safety and Health | .21(b)(6). |
| Welding and Cutting | .353(b), .352(g). |
| Containers: | |
| LP Gas | .153. |
| Welding and Cutting | .352(i), (j). |
| Contaminants (Definition) | .107(a). |
| Airborne, TLV | .55(a). |
| Contracts, Mixed Performance | .14. |
| Conveyors | .555. |
| Cranes | .550, .952(c), .955(b)(6)(i). |
| Crawling Boards | .451(v). |
| Current-Carrying Part (Definition) | .960(m). |
| Cutoffs, Fire | .150(f). |
| Cylinders, Welding and Cutting | .350. |
| D | |
| Dead (Definition) | .960(n). |
| Debarment | .4(b). |
| Decompression | .803(f). |
| Chambers | .803(g)(2). |
| Tables | .804. |
| Deenergized (Definition) | .960(n). |
| Deenergized Conductors, Stringing and Removing | .955(c). |
| Deenergizing Lines and Equipment | .950(d). |
| Disconnecting | .950(d)(2). |
| Guards and Barriers | .950(d)(1)(v), (d)(2)(i). |
| Identification | .950(d)(1)(i). |
| Inspections | .950(b), (d)(1)(iii). |
| Isolation | .950(d)(1)(i). |
| Notification by Designated Employee | .950(d)(1)(ii). |
| Protective Grounds | .950(d)(1)(iv). |
| Switches and Disconnectors | .950(d)(1)(ii). |
| Tagging | .950(d)(1)(ii)(b), (d)(1)(vi). |
| Work Completion | .950(d)(1)(vii), (d)(2)(ii). |
| Defect (Definition) | .32(g). |
| Demolition | .850. |
| Chutes | .852. |
| Entrances | .850(k). |
| Explosives | .860. |
| Flammable Gases | .850(e). |
| Floors | .850-.860. |
| Mechanical | .859. |
| Passageways | .851. |
| Stairways | .851. |
| Steel Construction | .858. |
| Derrick Trucks | .952(c). |
| Derricks | .550. |
| Designated Employee (Definition) | .960(o). |
| Designated Person (Definition) | .32(h). |
| Detonating Cords | .908. |
| Disposal: | |
| Exhaust Materials | .57(e). |
| Waste Materials | .252. |
| Diving Operations | .605(e). |
| Drilling, Tunnels and Shafts | .800(i). |
| Dusts | .55. |
| Conditions | .651(t). |
| E | |
| Ear Protection | .101. |
| Education and Training | .21. |
| Effective Dates | .1050, .1051. |
| Effectively Grounded (Definition) | .960(p). |
| Electric Line Trucks (Definition) | .960(q). |
| Electric Supply Lines (Definition) | .960(u). |
| Electric Transmission and Distribution Lines (see Power Transmission and Distribution Lines) | |
| Electrical, Electricity | .400. |
| Battery Rooms and Charging | .403. |
| Compressed Air Chambers | .803(j). |
| Cranes and Derricks | .550(a)(15). |
| Equipment Installation and Maintenance | .402. |
| Grounding and Bonding | .401. |
| Hazardous Locations | .404. |
| Power Operated Tools | .302(a). |
| Tunnels and Shafts | .800(1). |
| Electrode Conductor, Grounding | .954(h). |
| Definition | .960(bb). |
| Electrode Holders | .351 (a), (d). |
| Emergency Provisions: | |
| Excavations | .651. |
| Tunnels and Shafts | .800(b). |
| Employee (Definition) | .32(i). |
| Employer (Definition) | .32(j). |
| Enclosed (Definition) | .960(r). |
| Enclosed Spaces: | |
| Cranes and Derricks | .550(a)(11). |
| Welding and Cutting | .352(g). |
| Energized (Definition) | .960(a). |
| Energized Substations | .957. |
| Barricades and Barriers | .957(c). |
| Control Panels | .957(d). |
| Deenergized Equipment and Lines | .957(b). |
| Fences | .957(g). |
| Lowboys | .957(e)(3). |
| Mechanical Equipment | .957(e). |
| Storage | .957(f). |
| Warning Signs | .957(c)(2). |
| Work Authorizations | .957(a)(1). |
| Enforcement, Administrative, Adjudications for | .4. |
| Entrances (Demolition) | .850(k). |
| Entry, Right of | .3. |
| Environmental Controls | .50-.57. |
| Equipment: | |
| Definition | .960(s). |
| Earthmoving | .602. |
| Electrical | .402. |
| Firefighting | .150. |
| Lifesaving | .100-.106. |
| Marine | .605. |
| Mechanized | .600. |
| Pile Driving | .603. |
| Rigging | .251. |
| Excavations, Excavating: | |
| Equipment | .602(b), .955(b)(3)(i), .956(c), .957(h). |
| Trenching and Shoring | .650-.653. |
| Exhausts | .57. |
| Cranes and Derricks | .550(a). |
| Tunnels and Shafts | .800(c)(2)(vii). |
| Explosives | .900. |
| Loading | .905. |
| Storage | .904. |
| Surface Transportation | .902. |
| Underground Transportation | .903. |
| Exposed (Definition) | .960(t). |
| Eye Protection | .102. |
| F | |
| Face Protection | .102. |
| Fenders, Earthmoving Equipment | .602(a)(5). |
| Fire Alarm Devices | .150(e). |
| Fire Extinguishers | .150. |
| Cranes and Derricks | .550(a)(14). |
| Motor Vehicles | .600(b)(14). |
| Table F-1 (Fire Extinguishers) | .150. |
| Tunnels and Shafts | .800(e). |
| Welding and Cutting | .351. |
| Firefighting Equipment | .150 (c), (d). |
| Fire Prevention | .24, .150-.155. |
| Compressed Air | .803(l). |
| Oil and Grease Hazards | .350(i). |
| Preservative Coatings | .354. |
| Tunnels and Shafts | .800(e). |
| Welding and Cutting | .352-.354. |
| Fire Protection: | |
| Cutoffs | .150(f). |
| Prevention Program | .24. |

SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION—Continued
SUBJECT INDEX FOR 29 CFR PART 1926


| Subject term | Section No. |
|---|---|
| Water Supply and Equipment | .150–.155. |
| Fire Resistance (Definition) | .155(f). |
| Fires | .551(s). |
| First Aid | .23, .50, .950(e). |
| Marine Operations | .605(d). |
| Tunnels and Shafts | .803(b) (7), (8). |
| Fitting-Up | .752. |
| Flagmen | .201(a). |
| Flammable Gases Demolition | .850(e). |
| Flammable and Combustible Liquids | .152. |
| Flashpoint (Definition) | .155(l). |
| Floats: | |
| Bull | .700(d)(3). |
| Scaffolds | .451(w). |
| Floors, Flooring: | |
| Demolition | .850–.860. |
| Openings | .500. |
| Steel Erection | .750. |
| Food Handling | .51(d). |
| Footing Excavations | .955(b)(3)(i), .957(h). |
| Form, Forms, Formwork: | |
| Concrete | .700–.702. |
| Scaffolds | .451(x). |
| Fuel, Fueling and Refueling: | |
| Cranes and Derricks | .550(a)(14). |
| Diesel | .800(e). |
| Flammable and Combustible Liquids | .152. |
| Fuel Gases | .350(d), (e). |
| Fuel Powered Tools | .302(c). |
| LP Gas Dispensing | .153(e). |
| Oxygen Manifolds | .350(e). |
| Fumes: (see Ventilation) | .55. |
| Fuses, Safety | .907. |
| G | |
| Gases | .55. |
| Flammable Gases | .800(b). |
| Fuel Gases | .350(d). |
| Gaseous Conditions | .651(v). |
| Gloves | .951(a)(1)(iii). |
| Goggles | .102(a)(3). |
| Lasers | .102(b)(2). |
| Table E-1 (Eye and Face Protector Selection Guide) | .102. |
| Welding | .102(b)(1). |
| Grades, Roadway | .602(a)(3). |
| Grinding Machines | .303. |
| Ground (Noun) (Definition) | .960(x). |
| Ground (Reference) (Definition) | .960(w). |
| Ground (Verb) (Definition) | .960(y). |
| Ground Electrode (Definition) | .960(z). |
| Ground Lines | .551(l). |
| Ground Support: | |
| Excavations | .651. |
| Tunnels | .800(h). |
| Grounded Conductor (Definition) | .960(cc). |
| Grounded Effectively (Definition) | .960(p). |
| Grounded System (Definition) | .960(dd). |
| Grounding | .954. |
| Attaching Grounds | .954 (e), (f). |
| Ground Leads | .954(j). |
| Grounding Electrodes | .954(h). |
| New Construction | .954(b). |
| Removing Grounds | .954(e) (2), (8). |
| Testing: | |
| Voltage | .954(d). |
| Without Grounds | .954(g). |
| Towers | .954(i). |
| Wire Conductors | .954(c). |
| Grounding Conductor (Definition) | .960(bb). |
| Grounding Electrode (Definition) | .960(z). |
| Grounding Electrode Conductor (Definition) | .960(bb). |
| Grounding Electrode Resistance (Definition) | .960(aa). |
| Grounds, Grounding: | |
| Grounding and Bonding | .401. |
| Jumper Cables | .550(a)(15). |
| Return and Machine Grounding | .351(c). |
| Guarded (Definition) | .960(v). |
| Guardrails | .500. |
| Concrete Mixers | .700(d)(2). |
| Cranes and Derricks | .550(a)(13). |
| Scaffolding | .451. |
| Stairways | .500(e). |
| Standard Specifications | .500(f). |
| Steel Erection | .752. |
| Guys, Guying, Reinforcing Steel | .790(b)(3). |
| H | |
| Handlamps | .402(a)(9). |
| Handrails, Stairways | .501. |
| Hand Signals | .551(n). |
| Helicopters | Fig. N-1. |
| Handtools | .300–.305. |
| Hats | .951(a)(2). |
| Hauling, Haulage: | |
| Equipment | .602(c). |
| Tunnels and Shafts | .800(k). |
| Hazardous: | |
| Locations | .404. |
| Substances (Definition) | .32k. |
| Head Protection | .100. |
| Hearing Protection | .101. |
| Heaters, Heating, Temporary Devices | .154. |
| Helicopters | .551, .958. |
| Approach Distance | .551(o). |
| Approaching | .551(p). |
| Briefings | .551(b). |
| Cargo Hooks | .551(d). |
| Clothing | .551(e). |
| Communications | .551(r). |
| Fires | .551(s). |
| Ground Lines | .551(l). |
| Ground Personnel | .551(q). |
| Hooking and Unhooking Loads | .551(i). |
| Housekeeping | .551(g). |
| Loose Gear | .551(f). |
| Operator Responsibility | .551(h). |
| Personal Protective Equipment | .551(e). |
| Regulations | .551(a). |
| Signal Systems | .551(n). |
| Hand Signals | Fig. N-1. |
| Slings | .551(c). |
| Static Charges | .551(j). |
| Visibility | .551(m). |
| Weight Limitations | .551(k). |
| High Voltage Lines | .550(a)(15). |
| Hoists, Hoisting: | |
| Base-Mounted Drum | .553. |
| Materials | .552(b). |
| Overhead | .554. |
| Personnel (and Elevators) | .552(c). |
| Tunnels and Shafts | .800(m). |
| Horse Scaffolds | .451(o). |
| Hoses and Connections: | |
| Air Line Steel Erection | .752(a)(3). |
| Fire | .150(c)(2). |
| Manifold | .350(f). |
| Nozzles | .151(a)(5). |
| Pile Driving | .603(a)(9). |
| Pneumatic Power Tools | .302(b). |
| Hotline Tools (Definition) | .960(ee). |
| Housekeeping | .25. |
| Hydraulic: | |
| Jacks | .305. |
| Power Tools | .302(d). |
| I | |
| Incorporation by Reference | .31. |
| Identification Badges | .803(b)(11). |
| Ignition Hazards | .151(a). |
| Illumination | .26. |
| Demolition | .851(c). |
| Table D-3 (Minimum Illumination Intensities) | .56. |
| Temporary Lighting | .401(j). |
| Tunnels and Shafts | .800(d). |
| Industrial Trucks | .602(c). |
| Inert-Gas Metal-Arc Welding | .353(d). |
| Inspections | .955(a)(2), (b)(6)(v). |
| After Blasting | .910. |
| Cranes and Derricks | .550(a)(8). |
| Excavations | .650(i), .651. |
| Hoists and Elevators | .552(c)(15). |
| Right of Entry | .3. |
| Scaffolds | .451. |
| Shoring | .700(e)(1)(iii). |
| Tunnels | .800(h). |
| Insulated (Definition) | .960(ff). |
| Insulation (Cable) (Definition) | .960(gg). |
| Insulation Shielding (Definition) | .960(hh). |
| Interior Hung Scaffolds | .451(r). |
| Ionizing Radiation | .53. |
| Isolated (Definition) | .960(ii). |
| J | |
| Jacks | .305. |
| Lever and Ratchet Jacks | .305. |
| Trench | .652(j). |
| Jacob's Ladders | .605(b). |
| L | |
| Ladders | .951(c). |
| Chicken | .451(v). |
| Conductive | .951(c)(1). |
| Cranes and Derricks | .550(a)(13). |
| Demolition | .851. |
| Hook | .951(c)(2). |
| Jacob's | .605(b). |
| Ladder-Type Platforms | .451(l)(10)(i). |
| Marking | .951(c)(1). |
| Nonconductive | .951(c)(1). |
| Pile Driving | .603(c)(6). |
| Portable | .951(c)(1). |
| Securing | .951(c)(2). |
| Ladder Jack Scaffolds | .451(s). |
| Lanyards | .104, .556(b)(2)(vi), .959. |
| (see Body Belts, Safety Straps and Lanyards) | |
| Pile Driving | .603(a)(8). |
| Lasers: | |
| Eye Protection | .102(b)(2). |
| Nonionizing Radiation | .54. |
| Lenses | .102(a)(3). |
| Lasers | .102(b)(2). |
| Welding | .102(b)(1). |
| Lever and Ratchet Jacks | .305. |
| Lifelines | .104. |
| Materials Storage | .250(b)(2). |
| Scaffolding | .451 (l), (h), (p), (u), (w). |
| Lifesaving Equipment | .100–.106. |
| Marine Operations | .605(d). |
| Lift Slab Construction | .305(b). |
| Lifting Equipment | .602(c). |
| Lighting: (see Illumination) | .26, 56. |
| Portable Equipment | .151(a)(4). |
| Temporary | .401(j). |
| Linemen's Equipment (see Body Belts, Safety Straps and Lanyards) | |
| Lines, Underground (see Underground Lines) | |
| Liquefied Petroleum Gas (LP Gas) | .153. |
| Liquids, Flammable and Combustible | .152. |
| Live (Definition) | .960(a). |
| Live-line Bare-hand Work | .955(e). |
| Aerial Lifts | .955(e)(10)–(12). |
| Arm Current Tests | .955(e)(11). |
| Booms | .955(e)(9), (18)(i), (19), (20). |
| Bucket Liners, Conductive | .955(e)(7), (14). |
| Buckets, Conductive | .955(e)(17)–(20). |
| Circuit Interrupting Devices | .955(e)(5). |
| Electrical Storms | .955(e)(6). |
| Employee Training | .955(e)(1). |
| Ground Level Control | .955(e)(13). |
| Hand Lines | .955(e)(18)(i). |
| Minimum Distances | .950(c)(2) (i)–(ii); .955(e) (15)–(17), (20); Table V-2. |
| Load Attaching | .953(g). |
| Load Hooking and Unhooking | .551(i). |
| Loads: | |

SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION—Continued
SUBJECT INDEX FOR 29 CFR PART 1926


| Subject term | Section No. |
|---|---|
| Cranes and Derricks | .550(a)(2). |
| Hoists and Elevators | .552(a)(2). |
| Maximum Rated Loads | .451. |
| Ratings | .400(f). |
| Storage | .250(a)(2). |
| Table H-19 (Safe Working Loads for Shackles) | .252. |
| Table H-20 (Number and Spacing of U-Bolt Wire Rope Clips) | .252. |
| Locks: | |
| Man and Emergency | .803(g). |
| Medical | .803(b)(9). |
| M | |
| Manholes | .956(b). |
| Definition | .960(jj). |
| Excavating | .956(c). |
| Guarding | .956(b)(1). |
| Open Flames | .956(b) (2), (3). |
| Trenching Cables | .956(c), .956(c) (4)–(7). |
| Manifolds, Oxygen | .350(e). |
| Marine Operations | .605. |
| Working Over or Near Water | .106. |
| Masonry: | |
| Masons' Scaffolds | .451(h). |
| Removal | .854. |
| Material Handling | .953. |
| Framing | .953(f). |
| Load Attaching | .953(g). |
| Hoist Ropes | .953(g). |
| Oil Filled Equipment | .953(e). |
| Pole Hauling | .953(b). |
| Storage | .953(c). |
| Tag Lines | .953(d). |
| Unloading | .953(a). |
| Material Storage | .250, .953(c), .957(f). |
| Marine Operations | .605(a). |
| Safety Belts | .250(b)(2). |
| Mechanical Equipment | .952. |
| Aerial Lifts | .952(b). |
| Cranes | .952(c). |
| Derrick Trucks | .952(c). |
| Energized Substations | .957(e). |
| Inspections | .952(a). |
| Medical: (see First Aid) | |
| Attention | .23. |
| Examinations | .803(b). |
| Lock | .803(b)(9). |
| Services | .50. |
| Metal Tower Construction | .955(b). |
| Cranes | .955(b)(6)(i). |
| Footings | .955(b) (1)–(3). |
| Auger-type | .955(b)(2). |
| Excavations | .955(b)(3)(i). |
| Pad-type | .955(b)(1). |
| Pile-type | .955(b)(1). |
| Guy Lines | .955(b)(4)(ii). |
| Supports | .955(b)(4)(iii). |
| Midrails: | |
| Scaffolding | .451. |
| Specifications | .500(f). |
| Misfires | .911. |
| Mists | .55. |
| Mobile Scaffolds, Manually Propelled | .451(e). |
| Motor Vehicles | .600, .601. |
| Mud Flaps | .601(b)(13)(ii). |
| N | |
| Needle Beam Scaffolds | .451(p). |
| Nets, Safety | .105. |
| Steel Erection | .750(b)(1)(ii). |
| Noise Exposure | .52. |
| Nonionizing Radiation | .54. |
| O | |
| Occupational Health | .50–.57. |
| Oil Filled Equipment | .953(e). |
| Openings: | |
| Demolition | .850 (i), (j). |
| Floors and Walls | .500. |
| Underground | .800(a)(4). |
| Optical Density (Definition) | .107(d). |
| Table E-3 (Selecting Laser Safety Glass) | .102(b)(2). |
| Outrigger Scaffolds | .451(g). |
| Overcurrent Protection | .402(b). |
| Overhead Lines | .955. |
| Clearances | .955(b)(8). |
| Climbing Elevated Structures | .955(a) (2), (3). |
| Conductor Grips | .955(c)(8). |
| Deenergized Conductors | .500(c). |
| Erection Cranes | .955(b)(6)(i). |
| Inspections | .955 (a)(2), (b)(6)(v). |
| Lifting Equipment | .955(a)(6)(ii). |
| Loadlines | .955(b)(6)(iii). |
| Pole Holes | .955(a)(7). |
| Reel Handling Equipment | .955(c)(12). |
| Splicing | .965(c)(7)(iii), (d)(7). |
| Stringing | .955(c), (d). |
| Tag Lines | .955(a)(8), .955(b)(6)(ii). |
| Tower Assembly | .955(b) (4)–(6). |
| Traffic Control | .955(b)(7). |
| Transmission Clipping | .955(c)(10), (11)(ii); (d)(9). |
| Wind, Bad Weather | .955(b)(6)(iv), (c)(11)(i). |
| Overhead Protection | .451(a)(16), .1003. |
| Oxygen Manifolds | .350(e). |
| P | |
| Passageways, Walkways, Runways | .500(d). |
| Cranes and Derricks | .550(a)(13)(iii). |
| Demolition | .851(a). |
| Electrical Equipment | .400(d). |
| Personal Climbing Equipment (see Climbing Equipment). | |
| Personal Protective Equipment: (see Respiratory Protection) | .28, .100–.106, .551(e), .951(a). |
| Cutting, Welding, Heating | .553(c)(4). |
| Excavations | .650(e). |
| Gloves | .951(a)(1)(iii). |
| Hats | .951(a)(2). |
| Non-rubber | .951(a)(1)(iv). |
| Rubber | .951(a)(1) (i)–(iii). |
| Pier Holes, Trenching | .652(f). |
| Pile Driving | .603. |
| Pipelines, Piping | .351(c) (2), (3), (4). |
| Planks, Planking: | |
| Excavations | .650. |
| Hoists and Elevators | .552(b)(3). |
| Scaffolding | .451. |
| Steel Erection | .752. |
| Plasterers' and Decorators' Scaffolds | .451(q). |
| Platforms: | |
| Beam-Type | .451(i). |
| Catch | .451(u)(3). |
| Cranes and Derricks | .550(a)(13). |
| Elevating and Rotating Work | .451(f). |
| Guarding | .500(d). |
| Ladder-Type (2-pt. Suspension) | .451(i). |
| Light Metal-Type | .451(i). |
| Pile Driving | .603(a)(8). |
| Plumbing Up | .752(d). |
| Pneumatic Power Tools | .302(b). |
| Steel Erection | .752(a)(2). |
| Pole Hauling | .953(b). |
| Powder Actuated Tools | .302(e). |
| Powerlines, Cranes and Derricks | .550(a)(15). |
| Power-Operated Handtools | .302. |
| Power Transmission and Distribution Lines | .950–.960. |
| Clearances | .950(c). |
| Deenergizing Lines and Equipment | .950(d). |
| Emergency Procedures | .950(e). |
| Employee Insulation | .950(c)(1)(i), (iii). |
| Energized Parts | .950(c)(1)(i), (ii). |
| Existing Lines and Equipment | .950(a)(2). |
| First Aid | .950(e). |
| Hot Stick Distances | .950(c)(2)(i), Table V-1. |
| Hydraulic Fluids | .950(i). |
| Minimum Distances (see Hot Stick and Working Distances) | |
| Night Work | .950(f). |
| Sanitation | .950(h). |
| Water | .950(e). |
| Working Distances | .950(c)(2). |
| Pressure Vessels | .29(a). |
| Pile-Driving Equipment | .603(a). |
| Protective Equipment (see Personal Protective Equipment) | |
| Pulling Tension (Definition) | .960(kk). |
| Pumpcrete Systems | .700(d)(6). |
| Q | |
| Qualified (Definition) | .32(i). |
| Qualified Person (Definition) | .960(ll). |
| R | |
| Radiation: | |
| Inert-Gas Metal-Arc Welding | .353(d). |
| Ionizing | .53. |
| Nonionizing | .54. |
| Radiant Energy Protection: | |
| Lasers | .102(b)(2). |
| Welding | .102(b)(1). |
| Rated Capacity: | |
| Chain Slings | .251(b). |
| Synthetic Webbing | .251(e). |
| Table H-1 (Chain Slings, Steel) | .252. |
| Table H-2 (Maximum Allowable Wear at Any Point of Link) | .252. |
| Table H-3 (Single Leg Slings) | .252. |
| Table H-4 (Single Leg Slings) | .252. |
| Table H-5 (Single Leg Slings) | .252. |
| Table H-6 (Single Leg Slings) | .252. |
| Table H-7 (2-Leg and 3-Leg Bridal Slings) | .252. |
| Table H-8 (2-Leg and 3-Leg Bridal Slings) | .252. |
| Table H-9 (2-Leg and 3-Leg Bridal Slings) | .252. |
| Table H-10 (2-Leg and 3-Leg Bridal Slings) | .252. |
| Table H-11 (Strand Laid Grommet) | .252. |
| Table H-12 (Cable Laid Grommet) | .252. |
| Table H-13 (Strand Laid Endless Slings—Mechanical Joint Improved Plow Steel Grade Rope) | .252. |
| Table H-14 (Cable Laid Endless Slings—Mechanical Joint) | .252. |
| Table H-15 (Manila Rope Slings) | .252. |
| Table H-16 (Nylon Rope Slings) | .252. |
| Table H-17 (Polyester Rope Slings) | .252. |
| Table H-18 (Polypropylene Rope Slings) | .252. |
| Reference Ground (Definition) | .960(w). |
| Regulators | .350(d), (h). |
| Reinforcing Steel | .700(b). |
| Reorganization Plan No. 14 of 1950 | .12. |
| Rescue Crews | .800(e)(1)(xii). |
| Respiratory Protection | .103. |
| Excavations | .650(g). |
| Respirators | .103 (b), (c). |
| Tunnels and Shafts | .800(c). |
| Welding and Cutting | .353(c)(3). |
| Responsibilities: | |
| Accident Prevention | .20(b). |
| Contractors | .16. |
| Rigging: | |
| Cranes and Derricks | .550. |

SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION—Continued
SUBJECT INDEX FOR 29 CFR PART 1926


| Subject term | Section No. |
|---|---|
| Hoists and Elevators | .550. |
| Material Handling | .251. |
| Ring Buoys | .106(c). |
| Riveting | .752. |
| Rollover Protective Structures (see ROPS) | |
| Roof, Roofing, Brackets | .451(u). |
| Ropes: | |
| Cranes and Derricks | .550. |
| Definition | .960(ee). |
| Natural and Synthetic | 251(d). |
| Ropes, Wire: | |
| Cranes and Derricks | .550. |
| Hoists and Elevators | .552. |
| Rigging Equipment | .251(c). |
| Suspension | .552(c). |
| ROPS: (Rollover Protective Structures): | |
| Agricultural Tractors (Definition) | .1002(j). |
| Coverage | .1000 (a), (f). |
| Crawler Tractors | .1001. |
| Dozers | .1001. |
| Effective Dates | .1000 (b), (c). |
| Graders | .1001. |
| Industrial Tractors (Definition) | .1002(j). |
| Labeling | .1000(c). |
| Loaders | .1001. |
| Performance Requirements | .1001(f), .1002(c). |
| Protective Frames | .1002. |
| Remounting | .1000(d). |
| Scrapers | .1001. |
| Source of Standard | .1001(h). |
| Test Procedures | .1001(e), .1002 (d)-(h). |
| Test Setups | .1001(e)(iii). |
| Vehicle Weight (Definition) | .1001(g), .1002(e). |
| Runways: | |
| Excavations | .650. |
| Guarding | .500(d). |
| S | |
| SAE (Definition) | .32(o). |
| Safety and Health Provisions | .20. |
| Safety Belts (see Belts, Safety and Seat Belts). | |
| Safety Devices: | |
| Base-Mounted Drum Hoists | .553(a)(3). |
| Can, Safety (Definition) | .155(1). |
| Conveyors | .555(a)(3). |
| Hoists and Elevators | .552(b)(6), (c)(9). |
| Liquefied Petroleum Gas | .153(d). |
| Pneumatic Power Tools | .302(b)(8). |
| Tire Racks | .600(a)(2). |
| Safety Factor: | |
| Definition | .32(m). |
| Suspension Wire Ropes | .552(c). |
| Safety Fuses | .907. |
| Safety Nets: (see Nets, Safety): | |
| Safety Straps (see Body Belts, Safety Straps and Lanyards, Belts, Safety and Seat Belts). | .959. |
| Fabrics | .959(b)(1)(i), (ii). |
| Safe Working Loads | .252. |
| Table H-19 (Safe Working Loads for Shackles) | .252. |
| Table H-20 (Number and Spacing of U-Bolt Wire Rope Clips) | .252. |
| Salamanders, Solid Fuel | .154(d). |
| Sanitation | .27, .51, .950(h). |
| Compressed Air | .803(k). |
| Food Handling | .51(d). |
| Temporary Sleeping Quarters | .51(e). |
| Toilets | .51(c). |
| Water | .51 (a), (b). |
| Scaffolding, Scaffolds | .451. |
| Boatswain's Chair | .451(l). |
| Bricklayers' Square | .451(n). |
| Carpenters' Bracket | .451(m). |
| Crawling Boards or Chicken Ladders | .451(v). |
| Elevating and Rotating Work Platforms | .451(f). |
| Float or Ship | .451(w). |
| Form | .451(x). |
| Horse | .451(o). |
| Interior Hung | .451(r). |
| Ladder Jack | .451(s). |
| Manually Propelled Mobile | .451(e). |
| Masons' | .451(h). |
| Needle Beam | .451(p). |
| Outrigger | .451(g). |
| Plasterers', Decorators', and Large Area | .451(q). |
| Roofing Brackets and Catch Platforms | .451(u). |
| Single Point Adjustable Suspension | .451(k). |
| Stonesetters' Adjustable Suspension | .451(j). |
| Swinging 2-Point Suspension | .451(l). |
| Tube and Coupler | .451(c). |
| Tubular Welded Frame | .451(d). |
| Window Jack | .451(t). |
| Wood Pole | .451(b). |
| Screens, Screening | .351(e), .353(d). |
| Compressed Air | .803(m). |
| Screw Jacks | .305. |
| Seat Belts: | |
| Earthmoving Equipment | .602(a)(2). |
| Motor Vehicles | .601(b)(9). |
| Shackles and Hooks | .251(f). |
| Shafts | .800. |
| Shielding | .351(e). |
| Battery Rooms and Charging | .403(a)(5). |
| Shipbuilding and Ship Repairing | .30. |
| Ship Scaffolds | .451(w). |
| Shoring, Excavations and Trenching | .650. |
| Concrete and Concrete Forms | .700, .701. |
| Supporting Systems | .651. |
| Signaling, Signals | .201. |
| Cranes and Derricks | .550(a)(4). |
| Cranes and Hoists | .201(b). |
| Flagmen | .201(a). |
| Telephones | .803(e). |
| Tunnels and Shafts | .800(b)(4). |
| Signs, Accident Prevention | .200. |
| Conveyors | .555(a)(7). |
| Explosives | .903(m), .902(h). |
| Records | .803(d). |
| Single Post Shores | .701(d). |
| Site Clearing | .604. |
| Excavations | .651(b). |
| Fire Prevention | .151(c). |
| Skiffs, Lifesaving | .106(d). |
| Sleeping Quarters, Temporary | .51(e). |
| Slings | .551(c). |
| Smoking | .151(a)(3). |
| Soil: | |
| Excavations | .650, .651. |
| Trenching | .650, .652. |
| Specifications: | |
| Conveyors | .555. |
| Hoists and Elevators | .552. |
| Scaffolds | .451. |
| Standard Railings | .500(f). |
| Spectacles | .102. |
| Splicing | .955(c)(7)(iii), (d)(7). |
| Stairways | .500, .501. |
| Demolition | .851. |
| Standpipes | .150(d)(2). |
| Statutory Terms | .13. |
| Steel: | |
| Erection | .750. |
| Reinforcing | .700(b). |
| Removal of | .858. |
| Structural Steel Assembly | .751. |
| Storage: | |
| Demolition | .857. |
| Explosives | .904. |
| Indoor | .151(d), .152(b). |
| LP Gas Containers | .153(j), (k). |
| Material Handling | .250, .953(c), .957(f). |
| Open Yard | .151(c). |
| Outdoor | .152(c). |
| Static Charges | .551(j). |
| Stringing: | |
| Adjacent to Energized Lines | .955(d). |
| Deenergized Conductors | .955(c). |
| Substation: | |
| Fences | .957(g). |
| Supporting Systems | .651. |
| Suspension Scaffolds | .451 (j)-(k). |
| Switch (Definition) | .960(mm). |
| T | |
| Tag Lines | .551(c), .955(a), .955(b)(6)(ii). |
| Tags, Accident Prevention | .200(h). |
| Conveyors | .555(a)(7). |
| Definition | .960(nn). |
| Tagging of Circuits | .400(g). |
| Tanks, Potable | .152(c)(4). |
| Temporary Buildings | .151(b). |
| Threshold Limit Values (TLVs) | .55(a). |
| Tunnels and Shafts | .800(c). |
| Timber, Timbering: | |
| Excavations | .651. |
| Forms (Concrete) | .701(d)(7). |
| Trenching | .652. |
| Tire Safety Rack | .600(a)(2). |
| Toeboards: | |
| Scaffolding | .451. |
| Stand Specifications | .500(f). |
| Toilets | .51(c). |
| Tools | .951. |
| Hand | .951(f), .300, .302. |
| Hydraulic | .951(f)(3). |
| Inspections | .951(d)(2). |
| Live-line | .951(d). |
| Measuring Ropes | .951(e). |
| Measuring Tapes | .951(e). |
| Pneumatic | .951(f)(4). |
| Portable Electric | .951(f)(2). |
| Switches | .951(f)(1). |
| Tests | .951(d)(1). |
| Tools, Hand and Power | .300-.305. |
| Grounding | .401(a)(2). |
| Tools, Hotline (Definition) | .960(ee). |
| Torches | .350(g). |
| Toxic: | |
| Metals (Welding, Cutting and Heating) | .353(c). |
| Preservative Coatings | .354. |
| Trailing Cables | .402(a)(6). |
| Training and Education | .21. |
| Transformers | .402(d). |
| Transmitter Towers | .550(a)(15). |
| Trenching | .650, .652. |
| Trowels, Powered Concrete | .700(d)(4). |
| Trucks, Off-Highway | .602(a)(7). |
| Tube and Coupler: | |
| Scaffolds | .451(c). |
| Shoring | .701(c). |
| Tubular Welded Frame Scaffolds | .451(d). |
| Tunnels and Shafts | .800. |
| U | |
| Underground: | |
| Installations | .651(a). |
| Lines | .956. |
| Transportation of Explosives | .903. |
| Underwater Blasting | .912. |
| Unstable Material (Definition) | .960(oo). |
| V | |
| Vapors | .55. |
| Variations | .2. |
| Vault (Definition) | .960(pp). |
| Ventilation | .57. |
| Air Quality | .800(c). |
| Compressed Air | .803(i). |
| Preservative Coatings | .354. |
| Temporary Heating Devices | .154(a). |
| Welding and Cutting | .353. |
| Vertical Slip Form | .701(b). |
| Vests, Buoyant | .106. |
| Visibility | .551(k). |
| Voltage (Definition) | .960(qq). |

SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION—Continued
SUBJECT INDEX FOR 29 CFR PART 1926


| Subject term | Section No. |
|---|---|
| Voltage, Circuit Not Effectively Grounded (Definition) | .960(ss). |
| Voltage Effectively Grounded Circuit (Definition) | .960(rr). |
| W | |
| Walkways, Excavations | .650(a). |
| Wall: | |
| Openings, Guarding | .500(c). |
| Removal | .854-.856. |
| Washing Facilities | .51(f). |
| Waste Disposal: (see Disposal). | |
| Water: | |
| Marine Operations | .605. |
| Potable | .51(a). |
| Supply (for Fire Protection) | .150(b). |
| Working Over or Near | .106. |
| Webbing, Synthetic (for Slings) | .251(e). |
| Welding and Cutting | .350-.354. |
| Eye Protection | .102(b). |
| LPG Containers | .153(b). |
| Welding Standards | .556(b)(5). |
| Window Jack Scaffolds | .451(f). |
| Windows, Crane Cabs | .550(a)(12). |
| Wire Ropes (see Ropes, Wire) | |
| Wiring, Temporary | .401(h). |
| Wood Pole Scaffolds | .451(b). |
| Woodworking Tools | .304. |


The following requirements from Subpart T of 29 CFR 1910 (General Industry Standards) have been identified as applicable to construction (29 CFR Part 1926).

## PART 1910—OCCUPATIONAL SAFETY AND HEALTH STANDARDS

### Subpart T—Commercial Diving Operations


GENERAL

*1910.401 Scope and application.*
*1910.402 Definitions.*

PERSONNEL REQUIREMENTS

*1910.410 Qualifications of dive team.*
*1910.411 Medical requirements.*

GENERAL OPERATIONS PROCEDURES

*1910.420 Safe practices manual.*
*1910.421 Pre-dive procedures.*
*1910.422 Procedures during dive.*
*1910.423 Post-dive procedures.*

SPECIFIC OPERATIONS PROCEDURES

*1910.424 SCUBA diving.*
*1910.425 Surface-supplied air diving.*
*1910.426 Mixed-gas diving.*
*1910.427 Liveboating.*

EQUIPMENT PROCEDURES AND REQUIREMENTS

*1910.430 Equipment.*

RECORDKEEPING

*1910.440 Recordkeeping requirements.*
*1910.441 Effective date.*

*Appendix A—Examples of Conditions Which May Restrict or Limit Exposure to Hyperbaric Conditions.*


### Subpart T—Commercial Diving Operations

GENERAL

**§ 1910.401 Scope and application.**

(a) *Scope.* (1) This subpart (standard) applies to every place of employment within the waters of the United States, or within any State, the District of Columbia, the Commonwealth of Puerto Rico, the Virgin Islands, American Samoa, Guam, the Trust Territory of the Pacific Islands, Wake Island, Johnston Island, the Canal Zone, or within the Outer Continental Shelf lands as defined in the Outer Continental Shelf Lands Act (67 Stat. 462, 43 U.S.C. 1331), where diving and related support operations are performed.

(2) This standard applies to diving and related support operations conducted in connection with all types of work and employments, including general industry, construction, ship repairing, shipbuilding, shipbreaking and longshoring. However, this standard does not apply to any diving operation:

(i) Performed solely for instructional purposes, using open-circuit, compressed-air SCUBA and conducted within the no-decompression limits;

(ii) Performed solely for search, rescue, or related public safety purposes by or under the control of a governmental agency; or

(iii) Governed by 45 CFR Part 46 (Protection of Human Subjects, U.S. Department of Health, Education, and Welfare) or equivalent rules or regulations established by another federal agency, which regulate research, development, or related purposes involving human subjects.

(b) *Application in emergencies.* An employer may deviate from the requirements of this standard to the extent necessary to prevent or minimize a situation which is likely to cause death, serious physical harm, or major environmental damage, provided that the employer:

(1) Notifies the Area Director, Occupational Safety and Health Administration within 48 hours of the onset of the emergency situation indicating the nature of the emergency and extent of the deviation from the prescribed regulations; and

(2) Upon request from the Area Director, submits such information in writing.

(c) *Employer obligation.* The employer shall be responsible for compliance with:

(1) All provisions of this standard of general applicability; and

(2) All requirements pertaining to specific diving modes to the extent diving operations in such modes are conducted.

**§ 1910.402 Definitions.**

As used in this standard, the listed terms are defined as follows:

"Acfm": Actual cubic feet per minute.

"ASME Code or equivalent": ASME (American Society of Mechanical Engineers) Boiler and Pressure Vessel Code, Section VIII, or an equivalent code which the employer can demonstrate to be equally effective.

"ATA": Atmosphere absolute.

"Bell": An enclosed compartment, pressurized (closed bell) or unpressurized (open bell), which allows the diver to be transported to and from the underwater work area and which may be used as a temporary refuge during diving operations.

"Bottom time": The total elapsed time measured in minutes from the time when the diver leaves the surface in descent to the time that the diver begins ascent.

"Bursting pressure": The pressure at which a pressure containment device would fail structurally.

"Cylinder": A pressure vessel for the storage of gases.

"Decompression chamber": A pressure vessel for human occupancy such as a surface decompression chamber, closed bell, or deep diving system used to decompress divers and to treat decompression sickness.

"Decompression sickness": A condition with a variety of symptoms which may result from gas or bubbles in the tissues of divers after pressure reduction.

"Decompression table": A profile or set of profiles of depth-time relationships for ascent rates and breathing mixtures to be followed after a specific depth-time exposure or exposures.

"Dive location": A surface or vessel from which a diving operation is conducted.

"Dive-location reserve breathing gas": A supply system of air or mixed-gas (as appropriate) at the dive location which is independent of the primary supply system and sufficient to support divers during the planned decompression.

"Dive team": Divers and support employees involved in a diving operation, including the designated person-in-charge.

"Diver": An employee working in water using underwater apparatus which supplies compressed breathing gas at the ambient pressure.

"Diver-carried reserve breathing gas": A diver-carried supply of air or mixed gas (as appropriate) sufficient under standard operating conditions to allow the diver to reach the surface, or another source of breathing gas, or to be reached by a standby diver.

"Diving mode": A type of diving requiring specific equipment, procedures and techniques (SCUBA, surface-supplied air, or mixed gas).

"Fsw": Feet of seawater (or equivalent static pressure head).

"Heavy gear": Diver-worn deep-sea dress including helmet, breastplate, dry suit, and weighted shoes.

"Hyperbaric conditions": Pressure conditions in excess of surface pressure.

"Inwater stage": A suspended underwater platform which supports a diver in the water.

"Liveboating": The practice of supporting a surfaced-supplied air or mixed gas diver from a vessel which is underway.

"Mixed-gas diving": A diving mode in which the diver is supplied in the water with a breathing gas other than air.

"No-decompression limits": The depth-time limits of the "no-decompression limits and repetitive dive group designation table for no-decompression air dives", U.S. Navy Diving Manual or equivalent limits which the employer can demonstrate to be equally effective.

"Psi(g)": Pounds per square inch (gauge).

"SCUBA diving": A diving mode independent of surface supply in which the diver uses open circuit self-contained underwater breathing apparatus.

"Standby diver": A diver at the dive location available to assist a diver in the water.

"Surface-supplied air diving": A diving mode in which the diver in the water is supplied from the dive location with compressed air for breathing.

"Treatment table": A depth-time and breathing gas profile designed to treat decompression sickness.

"Umbilical": The composite hose bundle between a dive location and a diver or bell, or between a diver and a bell, which supplies the diver or bell with breathing gas, communications, power, or heat as appropriate to the diving mode or conditions, and includes a safety line between the diver and the dive location.

"Volume tank": A pressure vessel connected to the outlet of a compressor and used as an air reservoir.

"Working pressure": The maximum pressure to which a pressure containment device may be exposed under standard operating conditions.

PERSONNEL REQUIREMENTS

**§ 1910.410 Qualifications of dive team.**

(a) *General.* (1) Each dive team member shall have the experience or training necessary to perform assigned tasks in a safe and healthful manner.

(2) Each dive team member shall have experience or training in the following:

(i) The use of tools, equipment and systems relevant to assigned tasks;

(ii) Techniques of the assigned diving mode; and

(iii) Diving operations and emergency procedures.

(3) All dive team members shall be trained in cardiopulmonary resuscitation and first aid (American Red Cross standard course or equivalent).

(4) Dive team members who are exposed to or control the exposure of others to hyperbaric conditions shall be trained in diving-related physics and physiology.

(b) *Assignments.* (1) Each dive team member shall be assigned tasks in accordance with the employee's experience or training, except that limited additional tasks may be assigned to an employee undergoing training provided that these tasks are performed under the direct supervision of an experienced dive team member.

(2) The employer shall not require a dive team member to be exposed to hyperbaric conditions against the employee's will, except when necessary to complete decompression or treatment procedures.

(3) The employer shall not permit a dive team member to dive or be otherwise exposed to hyperbaric conditions for the duration of any temporary physical impairment or condition which is known to the employer and is likely to affect adversely the safety or health of a dive team member.

(c) *Designated person-in-charge.* (1) The employer or an employee designated by the employer shall be at the dive location in charge of all aspects of the diving operation affecting the safety and health of dive team members.

(2) The designated person-in-charge shall have experience and training in the conduct of the assigned diving operation.

**§ 1910.411 Medical requirements.**

(a) *General.* (1) The employer shall determine that dive team members who are, or are likely to be, exposed to hyperbaric conditions are medically fit to perform assigned tasks in a safe and healthful manner.

(2) The employer shall provide each dive team member who is, or is likely to be, exposed to hyperbaric conditions with all medical examinations required by this standard.

(3) All medical examinations required by this standard shall be performed by, or under the direction of, a physician at no cost to the employee.

(b) *Frequency of medical examinations.* Medical examinations shall be provided:

(1) Prior to initial hyperbaric exposure with the employer, unless an equivalent medical examination has been given within the preceding 12 months and the employer has obtained the results of the examination and an opinion from the examining physician of the employee's medical fitness to dive or to be otherwise exposed to hyperbaric conditions;

(2) At one-year intervals from the date of initial examination or last equivalent examination; and

(3) After an injury or illness requiring hospitalization of more than twenty-four (24) hours.

(c) *Information provided to examining physician.* The employer shall provide the following information to the examining physician:

(1) A copy of the medical requirements of this standard; and

(2) A summary of the nature and extent of hyperbaric conditions to which the dive team member will be exposed, including diving modes and types of work to be assigned.

(d) *Content of medical examinations.* (1) Medical examinations conducted initially and annually shall consist of the following:

(i) Medical history;

(ii) Diving-related work history;

(iii) Basic physical examination;

(iv) The tests required by Table I; and

(v) Any additional tests the physician considers necessary.

(2) Medical examinations conducted after an injury or illness requiring hospitalization of more than 24 hours shall be appropriate to the nature and extent of the injury or illness as determined by the examining physician.

TABLE I.—*Tests for diving medical examination*

| Test | Initial examination | Annual reexamination |
|---|---|---|
| Chest X-ray | X | |
| Visual acuity | X | X |
| Color blindness | X | |
| EKG: Standard 12L [1] | | |
| Hearing test | X | X |
| Hematocrit or hemoglobin | X | X |
| Sickle cell index | X | |
| White blood count | X | X |
| Urinalysis | X | X |

[1] To be given to the employee once, at age 35 or over.

(e) *Physician's written report.* (1) After any medical examination required by this standard, the employer shall obtain a written report prepared

by the examining physician containing:

(i) The results of the medical examination; and

(ii) The examining physician's opinion of the employee's fitness to be exposed to hyperbaric conditions, including any recommended restrictions or limitations to such exposure (see Appendix B).

(2) The employer shall provide the employee with a copy of the physician's written report.

(f) *Determination of employee fitness.* (1) The employer shall determine the extent and nature of the dive team member's fitness to engage in diving or be otherwise exposed to hyperbaric conditions consistent with the recommendations in the examining physician's report.

(2) If the examining physician has recommended a restriction or limitation on the dive team member's exposure to hyperbaric conditions, and the affected employee does not concur, a second physician selected by the employee shall render a medical opinion on the nature and extent of the restriction or limitation, if any.

(3) If the recommendation of the second opinion differs from that of the examining (first) physician, and if the employer and employee are unable to agree on the nature and extent of the restriction or limitation, an opinion from a third physician selected by the first two physicians shall be obtained. The employer's determination of the dive team member's fitness shall be consistent with the medical opinion of the third physician, unless the employer and employee reach an agreement which is otherwise consistent with the recommendation or opinion of at least two of the physicians involved.

(4) Nothing in this procedure shall be construed to prohibit either a dive team member from accepting, or an employer from offering, an assignment which is otherwise consistent with at least one medical opinion while a final determination on the employee's fitness is pending.

### General Operations Procedures

#### § 1910.420 Safe practices manual.

(a) *General.* The employer shall develop and maintain a safe practices manual which shall be made available at the dive location to each dive team member.

(b) *Contents.* (1) The safe practices manual shall contain a copy of this standard and the employer's policies for implementing the requirements of this standard.

(2) For each diving mode engaged in, the safe practices manual shall include:

(i) Safety procedures and checklists for diving operations;

(ii) Assignments and responsibilities of the dive team members;

(iii) Equipment procedures and checklists; and

(iv) Emergency procedures for fire, equipment failure, adverse environmental conditions, and medical illness and injury.

#### § 1910.421 Pre-dive procedures.

(a) *General.* The employer shall comply with the following requirements prior to each diving operation, unless otherwise specified.

(b) *Emergency aid.* A list shall be kept at the dive location of the telephone or call numbers of the following:

(1) An operational decompression chamber (if not at the dive location);

(2) Accessible hospitals;

(3) Available physicians;

(4) Available means of transportation; and

(5) The nearest U.S. Coast Guard Rescue Coordination Center.

(c) *First aid supplies.* (1) A first aid kit appropriate for the diving operation and approved by a physician shall be available at the dive location.

(2) When used in a decompression chamber or bell, the first aid kit shall be suitable for use under hyperbaric conditions.

(3) In addition to any other first aid supplies, an American Red Cross standard first aid handbook or equivalent, and a bag-type manual resuscitator with transparent mask and tubing shall be available at the dive location.

(d) *Planning and assessment.* Planning of a diving operation shall include an assessment of the safety and health aspects of the following:

(1) Diving mode;

(2) Surface and underwater conditions and hazards;

(3) Breathing gas supply (including reserves);

(4) Thermal protection;

(5) Diving equipment and systems;

(6) Dive team assignments and physical fitness of dive team members (including any impairment known to the employer);

(7) Repetitive dive designation or residual inert gas status of dive team members;

(8) Decompression and treatment procedures (including altitude corrections); and

(9) Emergency procedures.

(e) *Hazardous activities.* To minimize hazards to the dive team, diving operations shall be coordinated with other activities in the vicinity which are likely to interfere with the diving operation.

(f) *Employee briefing.* (1) Dive team members shall be briefed on:

(i) The tasks to be undertaken;

(ii) Safety procedures for the diving mode;

(iii) Any unusual hazards or environmental conditions likely to affect the safety of the diving operation; and

(iv) Any modifications to operating procedures necessitated by the specific diving operation.

(2) Prior to making individual dive team member assignments, the employer shall inquire into the dive team member's current state of physical fitness, and indicate to the dive team member the procedure for reporting physical problems or adverse physiological effects during and after the dive.

(g) *Equipment inspection.* The breathing gas supply system including reserve breathing gas supplies, masks, helmets, thermal protection, and bell handling mechanism (when appropriate) shall be inspected prior to each dive.

(h) *Warning signal.* When diving from surfaces other than vessels in areas capable of supporting marine traffic, a rigid replica of the international code flag "A" at least one meter in height shall be displayed at the dive location in a manner which allows all-round visibility, and shall be illuminated during night diving operations.

#### § 1910.422 Procedures during dive.

(a) *General.* The employer shall comply with the following requirements which are applicable to each diving operation unless otherwise specified.

(b) *Water entry and exit.* (1) A means capable of supporting the diver shall be provided for entering and exiting the water.

(2) The means provided for exiting the water shall extend below the water surface.

(3) A means shall be provided to assist an injured diver from the water or into a bell.

(c) *Communications.* (1) An operational two-way voice communication system shall be used between:

(i) Each surface-supplied air or mixed-gas diver and a dive team member at the dive location or bell (when provided or required); and

(ii) The bell and the dive location.

(2) An operational, two-way communication system shall be available at the dive location to obtain emergency assistance.

(d) *Decompression tables.* Decompression, repetitive, and no-decompression tables (as appropriate) shall be at the dive location.

(e) *Dive profiles.* A depth-time profile, including when appropriate any breathing gas changes, shall be maintained for each diver during the dive including decompression.

(f) *Hand-held power tools and equipment.* (1) Hand-held electrical tools and equipment shall be de-energized

before being placed into or retrieved from the water.

(2) Hand-held power tools shall not be supplied with power from the dive location until requested by the diver.

(g) *Welding and burning.* (1) A current supply switch to interrupt the current flow to the welding or burning electrode shall be:

(i) Tended by a dive team member in voice communication with the diver performing the welding or burning; and

(ii) Kept in the open position except when the diver is welding or burning.

(2) The welding machine frame shall be grounded.

(3) Welding and burning cables, electrode holders, and connections shall be capable of carrying the maximum current required by the work, and shall be properly insulated.

(4) Insulated gloves shall be provided to divers performing welding and burning operations.

(5) Prior to welding or burning on closed compartments, structures or pipes, which contain a flammable vapor or in which a flammable vapor may be generated by the work, they shall be vented, flooded, or purged with a mixture of gases which will not support combustion.

(h) *Explosives.* (1) Employers shall transport, store, and use explosives in accordance with this section and the applicable provisions of § 1910.109 and § 1926.912 of Title 29 of the Code of Federal Regulations.

(2) Electrical continuity of explosive circuits shall not be tested until the diver is out of the water.

(3) Explosives shall not be detonated while the diver is in the water.

(i) *Termination of dive.* The working interval of a dive shall be terminated when:

(1) A diver requests termination;

(2) A diver fails to respond correctly to communications or signals from a dive team member;

(3) Communications are lost and can not be quickly re-established between the diver and a dive team member at the dive location, and between the designated person-in-charge and the person controlling the vessel in live-boating operations; or

(4) A diver begins to use diver-carried reserve breathing gas or the dive-location reserve breathing gas.

**§ 1910.423 Post-dive procedures.**

(a) *General.* The employer shall comply with the following requirements which are applicable after each diving operation, unless otherwise specified.

(b) *Precautions.* (1) After the completion of any dive, the employer shall:

(i) Check the physical condition of the diver;

(ii) Instruct the diver to report any physical problems or adverse physiological effects including symptoms of decompression sickness;

(iii) Advise the diver of the location of a decompression chamber which is ready for use; and

(iv) Alert the diver to the potential hazards of flying after diving.

(2) For any dive outside the no-decompression limits, deeper than 100 fsw or using mixed gas as a breathing mixture, the employer shall instruct the diver to remain awake and in the vicinity of the decompression chamber which is at the dive location for at least one hour after the dive (including decompression or treatment as appropriate).

(c) *Recompression capability.* (1) A decompression chamber capable of recompressing the diver at the surface to a minimum of 165 fsw (6 ATA) shall be available at the dive location for:

(i) Surface-supplied air diving to depths deeper than 100 fsw and shallower than 220 fsw;

(ii) Mixed gas diving shallower than 300 fsw; or

(iii) Diving outside the no-decompression limits shallower than 300 fsw.

(2) A decompression chamber capable of recompressing the diver at the surface to the maximum depth of the dive shall be available at the dive location for dives deeper than 300 fsw.

(3) The decompression chamber shall be:

(i) Dual-lock;

(ii) Multiplace; and

(iii) Located within 5 minutes of the dive location.

(4) The decompression chamber shall be equipped with:

(i) A pressure gauge for each pressurized compartment designed for human occupancy;

(ii) A built-in-breathing-system with a minimum of one mask per occupant;

(iii) A two-way voice communication system between occupants and a dive team member at the dive location;

(iv) A viewport; and

(v) Illumination capability to light the interior.

(4) Treatment tables, treatment gas appropriate to the diving mode, and sufficient gas to conduct treatment shall be available at the dive location.

(5) A dive team member shall be available at the dive location during and for at least one hour after the dive to operate the decompression chamber (when required or provided).

(d) *Record of dive.* (1) The following information shall be recorded and maintained for each diving operation:

(i) Names of dive team members including designated person-in-charge;

(ii) Date, time, and location;

(iii) Diving modes used;

(iv) General nature of work performed;

(v) Approximate underwater and surface conditions (visibility, water temperature and current); and

(vi) Maximum depth and bottom time for each diver.

(2) For each dive outside the no-decompression limits, deeper than 100 fsw or using mixed gas, the following additional information shall be recorded and maintained:

(i) Depth-time and breathing gas profiles;

(ii) Decompression table designation (including modification); and

(iii) Elapsed time since last pressure exposure if less than 24 hours or repetitive dive designation for each diver.

(3) For each dive in which decompression sickness is suspected or symptoms are evident, the following additional information shall be recorded and maintained:

(i) Description of decompression sickness symptoms (including depth and time of onset); and

(ii) Description and results of treatment.

(e) *Decompression procedure assessment.* The employer shall:

(1) Investigate and evaluate each incident of decompression sickness based on the recorded information, consideration of the past performance of decompression table used, and individual susceptibility;

(2) Take appropriate corrective action to reduce the probability of recurrence of decompression sickness; and

(3) Prepare a written evaluation of the decompression procedure assessment, including any corrective action taken, within 45 days of the incident of decompression sickness.

SPECIFIC OPERATIONS PROCEDURES

**§ 1910.424 SCUBA diving.**

(a) *General.* Employers engaged in SCUBA diving shall comply with the following requirements, unless otherwise specified.

(b) *Limits.* SCUBA diving shall not be conducted:

(1) At depths deeper than 130 fsw;

(2) At depths deeper than 100 fsw or outside the no-decompression limits unless a decompression chamber is ready for use;

(3) Against currents exceeding one (1) knot unless line-tended; or

(4) In enclosed or physically confining spaces unless line-tended.

(c) *Procedures.*

(1) A standby diver shall be available while a diver is in the water.

(2) A diver shall be line-tended from the surface, or accompanied by another diver in the water in continuous visual contact during the diving operations.

(3) A diver shall be stationed at the underwater point of entry when diving

is conducted in enclosed or physically confining spaces.

(4) A diver-carried reserve breathing gas supply shall be provided for each diver consisting of:

(i) A manual reserve (J valve); or

(ii) An independent reserve cylinder with a separate regulator or connected to the underwater breathing apparatus.

(5) The valve of the reserve breathing gas supply shall be in the closed position prior to the dive.

§ 1910.425 Surface-supplied air diving.

(a) *General.* Employers engaged in surface-supplied air diving shall comply with the following requirements, unless otherwise specified.

(b) *Limits.* (1) Surface-supplied air diving shall not be conducted at depths deeper than 190 fsw, except that dives with bottom times of 30 minutes or less may be conducted to depths of 220 fsw.

(2) A decompression chamber shall be ready for use at the dive location for any dive outside the no-decompression limits or deeper than 100 fsw.

(3) A bell shall be used for dives with an inwater decompression time greater than 120 minutes, except when heavy gear is worn or diving is conducted in physically confining spaces.

(c) *Procedures.* (1) Each diver shall be continuously tended while in the water.

(2) A diver shall be stationed at the underwater point of entry when diving is conducted in enclosed or physically confining spaces.

(3) Each diving operation shall have a primary breathing gas supply sufficient to support divers for the duration of the planned dive including decompression.

(4) For dives deeper than 100 fsw or outside the no-decompression limits:

(i) A separate dive team member shall tend each diver in the water;

(ii) A standby diver shall be available while a diver is in the water;

(iii) A diver-carried reserve breathing gas supply shall be provided for each diver except when heavy gear is worn; and

(iv) A dive-location reserve breathing gas supply shall be provided.

(5) For heavy-gear diving deeper than 100 fsw or outside the no-decompression limits:

(i) An extra breathing gas hose capable of supplying breathing gas to the diver in the water shall be available to the standby diver.

(ii) An inwater stage shall be provided to divers in the water.

(6) Except when heavy gear is worn or where physical space does not permit, a diver-carried reserve breathing gas supply shall be provided whenever the diver is prevented by the configuration of the dive area from ascending directly to the surface.

§ 1910.426 Mixed-gas diving.

(a) *General.* Employers engaged in mixed-gas diving shall comply with the following requirements, unless otherwise specified.

(b) *Limits.* Mixed-gas diving shall be conducted only when:

(1) A decompression chamber is ready for use at the dive location; and

(i) A bell is used at depths greater than 220 fsw or when the dive involves inwater decompression time of greater than 120 minutes, except when heavy gear is worn or when diving in physically confining spaces; or

(ii) A closed bell is used at depths greater than 300 fsw, except when diving is conducted in physically confining spaces.

(c) *Procedures.* (1) A separate dive team member shall tend each diver in the water.

(2) A standby diver shall be available while a diver is in the water.

(3) A diver shall be stationed at the underwater point of entry when diving is conducted in enclosed or physically confining spaces.

(4) Each diving operation shall have a primary breathing gas supply sufficient to support divers for the duration of the planned dive including decompression.

(5) Each diving operation shall have a dive-location reserve breathing gas supply.

(6) When heavy gear is worn:

(i) An extra breathing gas hose capable of supplying breathing gas to the diver in the water shall be available to the standby diver; and

(ii) An inwater stage shall be provided to divers in the water.

(7) An inwater stage shall be provided for divers without access to a bell for dives deeper than 100 fsw or outside the no-decompression limits.

(8) When a closed bell is used, one dive team member in the bell shall be available and tend the diver in the water.

(9) Except when heavy gear is worn or where physical space does not permit, a diver-carried reserve breathing gas supply shall be provided for each diver:

(i) Diving deeper than 100 fsw or outside the no-decompression limits; or

(ii) Prevented by the configuration of the dive area from directly ascending to the surface.

§ 1910.427 Liveboating.

(a) *General.* Employers engaged in diving operations involving liveboating shall comply with the following requirements.

(b) *Limits.* Diving operations involving liveboating shall not be conducted:

(1) With an inwater decompression time of greater than 120 minutes;

(2) Using surface-supplied air at depths deeper than 190 fsw, except that dives with bottom times of 30 minutes or less may be conducted to depths of 220 fsw;

(3) Using mixed gas at depths greater than 220 fsw;

(4) In rough seas which significantly inpede diver mobility or work function; or

(5) In other than daylight hours.

(d) *Procedures.* (1) The propeller of the vessel shall be stopped before the diver enters or exits the water.

(2) A device shall be used which minimizes the possibility of entanglement of the diver's hose in the propeller of the vessel.

(3) Two-way voice communication between the designated person-in-charge and the person controlling the vessel shall be available while the diver is in the water.

(4) A standby diver shall be available while a diver is in the water.

(5) A diver-carried reserve breathing gas supply shall be carried by each diver engaged in liveboating operations.

EQUIPMENT PROCEDURES AND REQUIREMENTS

§ 1910.430 Equipment.

(a) *General.* (1) All employers shall comply with the following requirements, unless otherwise specified.

(2) Each equipment modification, repair, test, calibration or maintenance service shall be recorded by means of a tagging or logging system, and include the date and nature of work performed, and the name or initials of the person performing the work.

(b) *Air compressor systems.* (1) Compressors used to supply air to the diver shall be equipped with a volume tank with a check valve on the inlet side, a pressure gauge, a relief valve, and a drain valve.

(2) Air compressor intakes shall be located away from areas containing exhaust or other contaminants.

(3) Respirable air supplied to a diver shall not contain:

(i) A level of carbon monoxide (CO) greater than 20 ppm;

(ii) A level of carbon dioxide ($CO_2$) greater than 1,000 ppm;

(iii) A level of oil mist greater than 5 milligrams per cubic meter; or

(iv) A noxious or pronounced odor.

(4) The output of air compressor systems shall be tested for air purity every 6 months by means of samples taken at the connection to the distribution system, except that non-oil lubricated compressors need not be tested for oil mist.

(c) *Breathing gas supply hoses.* (1) Breathing gas supply hoses shall:

(i) Have a working pressure at least equal to the working pressure of the total breathing gas system;

(ii) Have a rated bursting pressure at least equal to 4 times the working pressure;

(iii) Be tested at least annually to 1.5 times their working pressure; and

(iv) Have their open ends taped, capped or plugged when not in use.

(2) Breathing gas supply hose connectors shall:

(i) Be made of corrosion-resistant materials;

(ii) Have a working pressure at least equal to the working pressure of the hose to which they are attached; and

(iii) Be resistant to accidental disengagement.

(3) Umbilicals shall:

(i) Be marked in 10-ft. increments to 100 feet beginning at the diver's end, and in 50 ft. increments thereafter;

(ii) Be made of kink-resistant materials; and

(iii) Have a working pressure greater than the pressure equivalent to the maximum depth of the dive (relative to the supply source) plus 100 psi.

(d) *Buoyancy control.* (1) Helmets or masks connected directly to the dry suit or other buoyancy-changing equipment shall be equipped with an exhaust valve.

(2) A dry suit or other buoyancy-changing equipment not directly connected to the helmet or mask shall be equipped with an exhaust valve.

(3) When used for SCUBA diving, a buoyancy compensator shall have an inflation source separate from the breathing gas supply.

(4) An inflatable flotation device capable of maintaining the diver at the surface in a face-up position, having a manually activated inflation source independent of the breathing supply, an oral inflation device, and an exhaust valve shall be used for SCUBA diving.

(e) *Compressed gas cylinders.* Compressed gas cylinders shall:

(1) Be designed, constructed and maintained in accordance with the applicable provisions of 29 CFR 1910.166-171;

(2) Be stored in a ventilated area and protected from excessive heat;

(3) Be secured from falling; and

(4) Have shut-off valves recessed into the cylinder or protected by a cap, except when in use or manifolded, or when used for SCUBA diving.

(f) *Decompression chambers.* (1) Each decompression chamber manufactured after the effective date of this standard, shall be built and maintained in accordance with the ASME Code or equivalent.

(2) Each decompression chamber manufactured prior to the effective date of this standard shall be maintained in conformity with the code requirements to which it was built, or equivalent.

(3) Each decompression chamber shall be equipped with:

(i) Means to maintain the atmosphere below a level of 25 percent oxygen be volume;

(ii) Mufflers on intake and exhaust lines, which shall be regularly inspected and maintained;

(iii) Suction guards on exhaust line openings; and

(iv) A means for extinguishing fire, and shall be maintained to minimize sources of ignition and combustible material.

(g) *Gauges and timekeeping devices.* (1) Gauges indicating diver depth which can be read at the dive location shall be used for all dives except SCUBA.

(2) Each depth gauge shall be deadweight tested or calibrated against a master reference gauge every 6 months, and when there is a discrepancy greater than two percent (2%) of full scale between any two equivalent gauges.

(3) A cylinder pressure gauge capable of being monitored by the diver during the dive shall be worn by each SCUBA diver.

(4) A timekeeping device shall be available at each dive location.

(h) *Masks and helmets.* (1) Surface-supplied air and mixed-gas masks and helmets shall have:

(i) A non-return valve at the attachment point between helmet or mask and hose which shall close readily and positively; and

(ii) An exhaust valve.

(2) Surface-supplied air masks and helmets shall have a minimum ventilation rate capability of 4.5 acfm at any depth at which they are operated or the capability of maintaining the diver's inspired carbon dioxide partial pressure below 0.02 ATA when the diver is producing carbon dioxide at the rate of 1.6 standard liters per minute.

(i) *Oxygen safety.* (1) Equipment used with oxygen or mixtures containing over forty percent (40%) by volume oxygen shall be designed for oxygen service.

(2) Components (except umbilicals) exposed to oxygen or mixtures containing over forty percent (40%) by volume oxygen shall be cleaned of flammable materials before use.

(3) Oxygen systems over 125 psig and compressed air systems over 500 psig shall have slow-opening shut-off valves.

(j) *Weights and harnesses.* (1) Except when heavy gear is worn, divers shall be equipped with a weight belt or assembly capable of quick release.

(2) Except when heavy gear is worn or in SCUBA diving, each diver shall wear a safety harness with:

(i) A positive buckling device;

(ii) An attachment point for the umbilical to prevent strain on the mask or helmet; and

(iii) A lifting point to distribute the pull force of the line over the diver's body.

RECORDKEEPING

**§ 1910.440 Recordkeeping requirements.**

(a) *Recording and Reporting.* (1) The employer shall record and report occupational injuries and illnesses in accordance with requirements of 29 CFR Part 1904.

(2) The employer shall record the occurrence of any diving-related injury or illness which requires any dive team member to be hospitalized for 24 hours or more, specifying the circumstances of the incident and the extent of any injuries or illnesses.

(b) *Availability of records.* (1) Upon the request of the Assistant Secretary of Labor for Occupational Safety and Health, or the Director, National Institute for Occupational Safety and Health, Department of Health, Education, and Welfare or their designees, the employer shall make available for inspection and copying any record or document required by this standard.

(2) Upon request of any employee, former employee or authorized representative, the employer shall make available for inspection and copying any record or document required by this standard which pertains to the individual employee or former employee.

(3) Records and documents required by this standard shall be retained by the employer for the following period:

(i) Dive team member medical records (physician's reports) (§ 1910.411)—5 years;

(ii) Safe practices manual (§ 1910.420)—current document only;

(iii) Depth-time profile (§ 1910.422)—until completion of the recording of dive, or until completion of decompression procedure assessment where there has been an incident of decompression sickness;

(iv) Recording of dive (§ 1910.423)—1 year, except 5 years where there has been an incident of decompression sickness;

(v) Decompression procedure assessment evaluations (§ 1910.423)—5 years;

(vi) Equipment inspections and testing records (§ 1910.430)—current entry or tag, or until equipment is withdrawn from service;

(vii) Records of hospitalizations (§ 1910.440)—5 years.

(4) After the expiration of the retention period of any record required to be kept for 5 years, the employer shall forward such records to the National Institute for Occupational Safety and Health, Department of Health, Education, and Welfare.

(5) In the event the employer ceases to do business:

(i) The successor employer shall receive and retain all dive and employee medical records required by this standard; or

(ii) If there is no successor employer, dive and employee medical records shall be forwarded to the National Institute for Occupational Safety and Health, Department of Health, Education, and Welfare.

§ 1910.441 Effective date.

This standard shall be effective on October 20, 1977, except that for provisions where decompression chambers or bells are required and such equipment is not yet available, employers shall comply as soon as possible thereafter but in no case later than 6 months after the effective date of the standard.

APPENDIX A—EXAMPLES OF CONDITIONS WHICH MAY RESTRICT OR LIMIT EXPOSURE TO HYPERBARIC CONDITIONS

The following disorders may restrict or limit occupational exposure to hyperbaric conditions depending on severity, presence of residual effects, response to therapy, number of occurrences, diving mode, or degree and duration of isolation.

History of seizure disorder other than early febrile convulsions.

Malignancies (active) unless treated and without recurrence for 5 yrs.

Chronic inability to equalize sinus and/or middle ear pressure.

Cystic or cavitary disease of the lungs.

Impaired organ function caused by alcohol or drug use.

Conditions requiring continuous medication for control (e.g., antihistamines, steroids, barbiturates, moodaltering drugs, or insulin).

Meniere's disease.

Hemoglobinopathies.

Obstructive or restrictive lung disease.

Vestibular end organ destruction.

Pneumothorax.

Cardiac abnormalities (e.g., pathological heart block, valvular disease, intraventricular conduction defects other than isolated right bundle branch block, angina pectoris, arrhythmia, coronary artery disease).

Juxta-articular osteonecrosis.

The following requirements from Subpart Z of 29 CFR Part 1910 (General Industry) have been identified as applicable to construction (29 CFR Part 1926).

## PART 1910—OCCUPATIONAL SAFETY AND HEALTH STANDARDS

### Subpart Z—Toxic and Hazardous Substances

* * * * *

Sec.

1910.1001 Asbestos.
1910.1002 Coal tar pitch volatiles; interpretation of term.
1910.1003 4-Nitrobiphenyl.
1910.1004 alpha-Naphthylamine.
1910.1005 [Reserved]
1910.1006 Methyl chloromethyl ether.
1910.1007 3,3'-Dichlorobenzidine (and its salts).
1910.1008 bis-Chloromethyl ether.
1910.1009 beta-Naphthylamine.
1910.1010 Benzidine.
1910.1011 4-Aminodiphenyl.
1910.1012 Ethyleneimine.
1910.1013 beta-Propiolactone.
1910.1014 2-Acetylaminofluorene.
1910.1015 4-Dimethylaminoazobenzene.
1910.1016 N-Nitrosodimethylamine.
1910.1017 Vinyl chloride.
1910.1018 Inorganic arsenic.
1910.1028 Benzene.
1910.1029 Coke oven emissions.
1910.1043 Cotton dust.
1910.1044 1,2-dibromo-3-chloropropane.
1910.1045 Acrylonitrile.
1910.1046a Exposure to cotton dust in cotton gins.

§ 1910.1001 Asbestos.

(a) *Definitions.* For the purpose of this section: (1) "Asbestos" includes chrysotile, amosite, crocidolite, tremolite, anthophyllite, and actinolite.

(2) "Asbestos fibers" means asbestos fibers longer than 5 micrometers.

(b) *Permissible exposure to airborne concentrations of asbestos fibers*—(1) *Standard effective July 7, 1972.* The 8-hour time-weighted average airborne concentrations of asbestos fibers to which any employee may be exposed shall not exceed five fibers, longer than 5 micrometers, per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section.

(2) *Standard effective July 1, 1976.* The 8-hour time-weighted average airborne concentrations of asbestos fibers to which any employee may be exposed shall not exceed two fibers, longer than 5 micrometers, per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section.

(3) *Ceiling concentration.* No employee shall be exposed at any time to airborne concentrations of asbestos fibers in excess of 10 fibers, longer than 5 micrometers, per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section.

(c) *Methods of compliance*—(1) *Engineering methods*—(i) *Engineering controls.* Engineering controls, such as, but not limited to, isolation, enclosure, exhaust ventilation, and dust collection, shall be used to meet the exposure limits prescribed in paragraph (b) of this section.

(ii) *Local exhaust ventilation.* (a) Local exhaust ventilation and dust collection systems shall be designed, constructed, installed, and maintained in accordance with the American National Standard Fundamentals Governing the Design and Operation of Local Exhaust Systems, ANSI Z9.2-1971, which is incorporated by reference herein.

(b) See § 1910.6 concerning the availability of ANSI Z9.2-1971, and the maintenance of a historic file in connection therewith. The address of the American National Standards Institute is given in § 1910.100.

(iii) *Particular tools.* All hand-operated and power-operated tools which may produce or release asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section, such as, but not limited to, saws, scorers, abrasive wheels, and drills, shall be provided with local exhaust ventilation systems in accordance with subdivision (ii) of this subparagraph.

(2) *Work practices*—(i) *Wet methods.* Insofar as practicable, asbestos shall be handled, mixed, applied, removed, cut, scored, or otherwise worked in a wet state sufficient to prevent the emission of airborne fibers in excess of the exposure limits prescribed in paragraph (b) of this section, unless the usefulness of the product would be diminished thereby.

(ii) *Particular products and operations.* No asbestos cement, mortar, coating, grout, plaster, or similar material containing asbestos shall be removed from bags, cartons, or other containers in which they are shipped, without being either wetted, or enclosed, or ventilated so as to prevent effectively the release of airborne asbestos fibers in excess of the limits prescribed in paragraph (b) of this section.

(iii) *Spraying, demolition, or removal.* Employees engaged in the spraying of asbestos, the removal, or demolition of pipes, structures, or equipment covered or insulated with asbestos, and in the removal or demolition of asbestos insulation or coverings shall be provided with respiratory equipment in accordance with paragraph (d)(2)(iii) of this section and with special clothing in accordance with paragraph (d)(3) of this section.

(d) *Personal protective equipment*—(1) Compliance with the exposure limits prescribed by paragraph (b) of this section may not be achieved by the use of respirators or shift rotation of employees, except:

(i) During the time period necessary to install the engineering controls and to institute the work practices required by paragraph (c) of this section;

(ii) In work situations in which the methods prescribed in paragraph (c) of this section are either technically not feasible or feasible to an extent insufficient to reduce the airborne concentrations of asbestos fibers below the limits prescribed by paragraph (b) of this section; or

(iii) In emergencies.

(iv) Where both respirators and personnel rotation are allowed by subdivisions (i), (ii), or (iii) of this subparagraph and both are practicable, per-

sonnel rotation shall be preferred and used.

(2) Where a respirator is permitted by subparagraph (1) of this paragraph, it shall be selected from among those approved by the Bureau of Mines, Department of the Interior, or the National Institute for Occupational Safety and Health, Department of Health, Education, and Welfare, under the provisions of 30 CFR Part 11 (37 F.R. 6244, Mar. 25, 1972), and shall be used in accordance with subdivisions (i), (ii), (iii), and (iv) of this subparagraph.

(i) *Air purifying respirators.* A reusable or single use air purifying respirator, or a respirator described in subdivision (ii) or (iii) of this subparagraph, shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour time-weighted average airborne concentrations of asbestos fibers are reasonably expected to exceed no more than 10 times those limits.

(ii) *Powered air purifying respirators.* A full facepiece powered air purifying respirator, or a powered air purifying respirator, or a respirator described in subdivision (iii) of this subparagraph, shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour time-weighted average concentrations of asbestos fibers are reasonably expected to exceed 10 times, but not 100 times, those limits.

(iii) *Type "C" supplied-air respirators, continuous flow or pressure-demand class.* A type "C" continuous flow or pressure-demand, supplied-air respirator shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour time-weighted average airborne concentrations of asbestos fibers are reasonably expected to exceed 100 times those limits.

(iv) *Establishment of a respirator program. (a) The employer shall establish a respirator program in accordance with the requirements of the American National Standards Practices for Respiratory Protection, ANSI Z88.2-1969, which is incorporated by reference herein.*

(b) See § 1910.6 concerning the availability of ANSI Z88.2-1969 and the maintenance of a historic file in connection therewith. The address of the American National Standards Institute is given in § 1910.100.

(c) No employee shall be assigned to tasks requiring the use of respirators if, based upon his most recent examination, an examining physician determines that the employee will be unable to function normally wearing a respirator, or that the safety or health of the employee or other employees will be impaired by his use of a respirator. Such employee shall be rotated to another job or given the opportunity to transfer to a different position whose duties he is able to perform with the same employer, in the same geographical area and with the same seniority, status, and rate of pay he had just prior to such transfer, if such a different position is available.

(3) *Special clothing.* The employer shall provide, and require the use of, special clothing, such as coveralls or similar whole body clothing, head coverings, gloves, and foot coverings for any employee exposed to airborne concentrations of asbestos fibers, which exceed the ceiling level prescribed in paragraph (b) of this section.

(4) *Change rooms.* (i) At any fixed place of employment exposed to airborne concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section, the employer shall provide change rooms for employees working regularly at the place.

(ii) *Clothes lockers.* The employer shall provide two separate lockers or containers for each employee, so separated or isolated as to prevent contamination of the employee's street clothes from his work clothes.

(iii) *Laundering.* (a) Laundering of asbestos contaminated clothing shall be done so as to prevent the release of air-borne asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section.

(b) Any employer who gives asbestos-contaminated clothing to another person for laundering shall inform such person of the requirement in (a) of this subdivision to effectively prevent the release of airborne asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section.

(c) Contaminated clothing shall be transported in sealed impermeable bags, or other closed, impermeable containers, and labeled in accordance with paragraph (g) of this section.

(e) *Method of measurement.* All determinations of airborne concentrations of asbestos fibers shall be made by the membrane filter method at 400–450 × (magnification) (4 millimeter objective) with phase contrast illumination.

(f) *Monitoring*—(1) *Initial determinations.* Within 6 months of the publication of this section, every employer shall cause every place of employment where asbestos fibers are released to be monitored in such a way as to determine whether every employee's exposure to asbestos fibers is below the limits prescribed in paragraph (b) of this section. If the limits are exceeded, the employer shall immediately undertake a compliance program in accordance with paragraph (c) of this section.

(2) *Personal monitoring*—(i) Samples shall be collected from within the breathing zone of the employees, on membrane filters of 0.8 micrometer porosity mounted in an open-face filter holder. Samples shall be taken for the determination of the 8-hour time-weighted average airborne concentrations and of the ceiling concentrations of asbestos fibers.

(ii) *Sampling frequency and patterns.* After the initial determinations required by subparagraph (1) of this paragraph, samples shall be of such frequency and pattern as to represent with reasonable accuracy the levels of exposure of employees. In no case shall the sampling be done at intervals greater than 6 months for employees whose exposure to asbestos may reasonably be foreseen to exceed the limits prescribed by paragraph (b) of this section.

(3) *Environmental monitoring*—(i) samples shall be collected from areas of a work environment which are representative of the airborne concentrations of asbestos fibers which may reach the breathing zone of employees. Samples shall be collected on a membrane filter of 0.8 micrometer porosity mounted in an open-face filter holder. Samples shall be taken for the determination of the 8-hour time-weighted average airborne concentrations and of the ceiling concentrations of asbestos fibers.

(ii) *Sampling frequency and patterns.* After the initial determinations required by subparagraph (1) of this paragraph, samples shall be of such frequency and pattern as to represent with reasonable accuracy the levels of exposure of the employees. In no case shall sampling be at intervals greater than 6 months for employees whose exposures to asbestos may reasonably be foreseen to exceed the exposure limits prescribed in paragraph (b) of this section.

(4) *Employee observation of monitoring.* Affected employees, or their representatives, shall be given a reasonable opportunity to observe any monitoring required by this paragraph and shall have access to the records thereof.

(g) *Caution signs and labels*—(1) *Caution signs*—(i) *Posting.* Caution signs shall be provided and displayed at each location where airborne concentrations of asbestos fibers may be in excess of the exposure limits prescribed in paragraph (b) of this section. Signs shall be posted at such a distance from such a location so that an employee may read the signs and take necessary protective steps before

entering the area marked by the signs. Signs shall be posted at all approaches to areas containing excessive concentrations of airborne asbestos fibers.

(ii) *Sign specifications.* The warning signs required by subdivision (i) of this subparagraph shall conform to the requirements of 20" × 14" vertical format signs specified in § 1910.145(d)(4), and to this subdivision. The signs shall display the following legend in the lower panel, with letter sizes and styles of a visibility at least equal to that specified in this subdivision.

| *Legend* | *Notation* |
|---|---|
| Asbestos | 1" Sans Serif, Gothic or Block. |
| Dust Hazard | ¾" Sans Serif, Gothic or Block. |
| Avoid Breathing Dust | ¼" Gothic. |
| Wear Assigned Protective Equipment. | ¼" Gothic. |
| Do Not Remain In Area Unless Your Work Requires It. | ⅛" Gothic. |
| Breathing Asbestos Dust May Be Hazardous To Your Health. | 14 point Gothic. |

Spacing between lines shall be at least equal to the height of the upper of any two lines.

(2) *Caution labels*—(i) *Labeling.* Caution labels shall be affixed to all raw materials, mixtures, scrap, waste, debris, and other products containing asbestos fibers, or to their containers, except that no label is required where asbestos fibers have been modified by a bonding agent, coating, binder, or other material so that during any reasonably foreseeable use, handling, storage, disposal, processing, or transportation, no airborne concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section will be released.

(ii) *Label specifications.* The caution labels required by subdivision (i) of this subparagraph shall be printed in letters of sufficient size and contrast as to be readily visible and legible. The label shall state:

CAUTION

Contains Asbestos Fibers

Avoid Creating Dust

Breathing Asbestos Dust May Cause Serious Bodily Harm

(h) *Housekeeping*—(1) *Cleaning.* All external surfaces in any place of employment shall be maintained free of accumulations of asbestos fibers if, with their dispersion, there would be an excessive concentration.

(2) *Waste disposal.* Asbestos waste, scrap, debris, bags, containers, equipment, and asbestos-contaminated clothing, consigned for disposal, which may produce in any reasonably foreseeable use, handling, storage, processing, disposal, or transportation airborne concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section shall be collected and disposed of in sealed impermeable bags, or other closed, impermeable containers.

(i) *Recordkeeping*—(1) *Exposure records.* Every employer shall maintain records of any personal or environmental monitoring required by this section. Records shall be maintained for a period of at least 20 years and shall be made available upon request to the Assistant Secretary of Labor for Occupational Safety and Health, the Director of the National Institute for Occupational Safety and Health, and to authorized representatives of either.

(2) *Employee access.* Every employee and former employee shall have reasonable access to any record required to be maintained by subparagraph (1) of this paragraph, which indicates the employee's own exposure to asbestos fibers.

(3) *Employee notification.* Any employee found to have been exposed at any time to airborne concentrations of asbestos fibers in excess of the limits prescribed in paragraph (b) of this section shall be notified in writing of the exposure as soon as practicable but not later than 5 days of the finding. The employee shall also be timely notified of the corrective action being taken.

(j) *Medical examinations*—(1) *General.* The employer shall provide or make available at his cost, medical examinations relative to exposure to asbestos required by this paragraph.

(2) *Preplacement.* The employer shall provide or make available to each of his employees, within 30 calendar days following his first employment in an occupation exposed to airborne concentrations of asbestos fibers, a comprehensive medical examination, which shall include, as a minimum, a chest roentgenogram (posterior-anterior 14 × 17 inches), a history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second ($FEV_{1.0}$).

(3) *Annual examinations.* On or before January 31, 1973, and at least annually thereafter, every employer shall provide, or make available, comprehensive medical examinations to each of his employees engaged in occupations exposed to airborne concentrations of asbestos fibers. Such annual examination shall include, as a minimum, a chest roentgenogram (posterior-anterior 14 × 17 inches), a history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second ($FEV_{1.0}$).

(4) *Termination of employment.* The employer shall provide, or make available, within 30 calendar days before or after the termination of employment of any employee engaged in an occupation exposed to airborne concentrations of asbestos fibers, a comprehensive medical examination which shall include, as a minimum, a chest roentgenogram (posterior-anterior 14 × 17 inches), a history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second ($FEV_{1.0}$).

(5) *Recent examinations.* No medical examination is required of any employee, if adequate records show that the employee has been examined in accordance with this paragraph within the past 1-year period.

(6) *Medical records*—(i) *Maintenance.* Employers of employees examined pursuant to this paragraph shall cause to be maintained complete and accurate records of all such medical examinations. Records shall be retained by employers for at least 20 years.

(ii) *Access.* The contents of the records of the medical examinations required by this paragraph shall be made available, for inspection and copying, to the Assistant Secretary of Labor for Occupational Safety and Health, the Director of NIOSH, to authorized physicians and medical consultants of either of them, and, upon the request of an employee or former employee, to his physician. Any physician who conducts a medical examination required by this paragraph shall furnish to the employer of the examined employee all the information specifically required by this paragraph, and any other medical information related to occupational exposure to asbestos fibers.

### § 1910.1002 Coal tar pitch volatiles; interpretation of term.

As used in § 1910.1000 (Table Z-1), coal tar pitch volatiles include the fused polycyclic hydrocarbons which volatilize from the distillation residues of coal, petroleum, wood, and other organic matter.

### § 1910.1003 4-Nitrobiphenyl.

(a) *Scope and application.* (1) This section applies to any area in which 4-Nitrobiphenyl, Chemical Abstracts Service Registry Number 92933 is manufactured, processed, repackaged, released, handled, or stored, but shall not apply to transshipment in sealed containers, except for the labeling requirements under paragraphs (e) (2), (3), and (4) of this section.

(2) This section shall not apply to solid or liquid mixtures containing less than 0.1 percent by weight or volume of 4-Nitrobiphenyl.

(b) *Definitions.* For the purposes of this section:

(1) "Absolute filter aerosol" is one capable of retaining 99.97 percent of a mono disperse aerosol of 0.3 μm particles.

(2) "Authorized employee" means an employee whose duties require him to be in the regulated area and who has been specifically assigned by the employer.

(3) "Clean change room" means a room where employees put on clean clothing and/or protective equipment in an environment free of 4-Nitrobiphenyl. The clean change room shall be contiguous to and have an entry from a shower room, when the shower room facilities are otherwise required in this section.

(4) "Closed system" means an operation involving 4-Nitrobiphenyl where containment prevents the release of 4-Nitrobiphenyl into regulated areas, non-regulated areas, or the external environment.

(5) "Decontamination" means the inactivation of 4-Nitrobiphenyl or its safe disposal.

(6) "Director" means the Director, National Institute for Occupational Safety and Health, or any person directed by him or the Secretary of Health, Education, and Welfare to act for the Director.

(7) "Disposal" means the safe removal of 4-Nitrobiphenyl from the work environment.

(8) "Emergency" means an unforeseen circumstance or set of circumstances resulting in the release of 4-Nitrobiphenyl which may result in exposure to or contact with 4-Nitrobiphenyl.

(9) "External environment" means any environment external to regulated and nonregulated areas.

(10) "Isolated system" means a fully enclosed structure other than the vessel of containment of 4-Nitrobiphenyl, which is impervious to the passage of 4-Nitrobiphenyl, and which would prevent the entry of 4-Nitrobiphenyl into regulated areas, nonregulated areas, or the external environment, should leakage or spillage from the vessel of containment occur.

(11) "Laboratory type hood" is a device enclosed on three sides and the top and bottom, designed and maintained so as to draw air inward at an average linear face velocity of 150 feet per minute with a minimum of 125 feet per minute; designed, constructed, and maintained in such a way that an operation involving 4-Nitrobiphenyl within the hood does not require the insertion of any portion of any employee's body other than his hands and arms.

(12) "Nonregulated area" means any area under the control of the employer where entry and exit is neither restricted nor controlled.

(13) "Open-vessel system" means an operation involving 4-Nitrobiphenyl in an open vessel, which is not in an isolated system, a laboratory type hood, nor in any other system affording equivalent protection against the entry of 4-Nitrobiphenyl into regulated areas, non-regulated areas, or the external environment.

(14) "Protective clothing" means clothing designed to protect an employee against contact with or exposure to 4-Nitrobiphenyl.

(15) "Regulated area" means an area where entry and exit is restricted and controlled.

(c) "Requirements for areas containing 4-Nitrobiphenyl." A regulated area shall be established by an employer where 4-Nitrobiphenyl is manufactured, processed, used, repackaged, released, handled or stored. All such areas shall be controlled in accordance with the requirements for the following category or categories describing the operation involved: (1) *Isolated systems.* Employees working with 4-Nitrobiphenyl within an isolated system such as a "glove box" shall wash their hands and arms upon completion of the assigned task and before engaging in other activities not associated with the isolated system.

(2) *Closed system operation.* Within regulated areas where 4-Nitrobiphenyl is stored in sealed containers, or contained in a closed system, including piping systems, with any sample ports or openings closed while 4-Nitrobiphenyl is contained within: (i) Access shall be restricted to authorized employees only;

(ii) Employees shall be required to wash hands, forearms, face and neck upon each exit from the regulated areas, close to the point of exit and before engaging in other activities.

(3) *Open vessel system operations.* Open vessel system operations as defined in paragraph (b)(13) of this section are prohibited.

(4) *Transfer from a closed system, charging or discharging point operations, or otherwise opening a closed system.* In operations involving "laboratory type hoods," or in locations where 4-Nitrobiphenyl is contained in an otherwise "closed system," but is transferred, charged, or discharged into other normally closed containers, the provisions of this subparagraph shall apply.

(i) Access shall be restricted to authorized employees only;

(ii) Each operation shall be provided with continuous local exhaust ventilation so that air movement is always from ordinary work areas to the operation. Exhaust air shall not be discharged to regulated areas, nonregulated areas or the external environment unless decontaminated. Clean makeup air shall be introduced in sufficient volume to maintain the correct operation of the local exhaust system.

(iii) Employees shall be provided with, and required to wear, clean, full body protective clothing (smocks, coveralls, or long-sleeved shirt and pants), shoe covers and gloves prior to entering the regulated area.

(iv) Employees engaged in 4-Nitrobiphenyl handling operations shall be provided with and required to wear and use a half-face, filter-type respirator for dusts, mists, and fumes, in accordance with § 1910.134. A respirator affording higher levels of protection may be substituted.

(v) Prior to each exit from a regulated area, employees shall be required to remove and leave protective clothing and equipment at the point of exit and at the last exit of the day, to place used clothing and equipment in impervious containers at the point of exit for purposes of decontamination or disposal. The contents of such impervious containers shall be identified, as required under paragraphs (e) (2), (3), and (4) of this section.

(vi) Employees shall be required to wash hands, forearms, face and neck on each exit from the regulated area, close to the point of exit, and before engaging in other activities.

(vii) Employees shall be required to shower after the last exit of the day.

(viii) Drinking fountains are prohibited in the regulated area.

(5) *Maintenance and decontamination activities.* In cleanup of leaks or spills, maintenance or repair operations on contaminated systems or equipment, or any operations involving work in an area where direct contact with 4-Nitrobiphenyl could result, each authorized employee entering that area shall: (i) Be provided with and required to wear clean, impervious garments, including gloves, boots and continuous-air supplied hood in accordance with § 1910.134.

(ii) Be decontaminated before removing the protective garments and hood;

(iii) Be required to shower upon removing the protective garments and hood.

(6) *Laboratory activities.* [Deleted]

(d) *General regulated area requirements*—(1) *Employee identification.* A daily roster of employees entering regulated areas shall be established and maintained. The rosters or a summary of the rosters, shall be retained for a period of 20 years. The rosters and/or summaries shall be provided upon request to authorized representatives of the Assistant Secretary and the Director. In the event that the employer ceases business without a successor, rosters shall be forwarded by registered mail to the Director.

(2) *Emergencies.* In an emergency, immediate measures including, but not limited to, the requirements of subdivisions (i), (ii), (iii), (iv), and (v) of this paragraph shall be implemented. (i) The potentially affected area shall be evacuated as soon as the emergency has been determined.

(ii) Hazardous conditions created by the emergency shall be eliminated and the potentially affected area shall be decontaminated prior to the resumption of normal operations.

(iii) Special medical surveillance by a physician shall be instituted with 24 hours for employees present in the potentially affected area at the time of the emergency. A report of the medical surveillance and any treatment shall be included in the incident report, in accordance with paragraph (f)(2) of this section.

(iv) Where an employee has a known contact with 4-Nitrobiphenyl such employee shall be required to shower as soon as possible, unless contraindicated by physical injuries.

(v) An incident report on the emergency shall be reported as provided in paragraph (f)(2) of this section.

(3) *Hygiene facilities and practices.* (i) Storage or consumption of food, storage or use of containers of beverages, storage or application of cosmetics, smoking, storage of smoking materials, tobacco products or other products for chewing, or the chewing of such products, are prohibited in regulated areas.

(ii) Where employees are required by this section to wash, washing facilities shall be provided in accordance with § 1910.141(d) (1) and (2) (ii) through (vii).

(iii) Where employees are required by this section to shower, shower facilities shall be provided in accordance with § 1910.141(d)(3).

(iv) Where employees wear protective clothing and equipment, clean change rooms shall be provided, in accordance with § 1910.141(e), for the number of such employees required to change clothes.

(v) Where toilets are in regulated areas, such toilets shall be in a separate room.

(4) *Contamination control.* (i) Regulated areas, except for outdoor systems, shall be maintained under pressure negative with respect to nonregulated areas. Local exhaust ventilation may be used to satisfy this requirement. Clean makeup air in equal volume shall replace air removed.

(ii) Any equipment, materials, or other item taken into or removed from a regulated area shall be done so in a manner that does not cause contamination in nonregulated areas or the external environment.

(iii) Decontamination procedures shall be established and implemented to remove 4-Nitrobiphenyl from the surfaces of materials, equipment and the decontamination facility.

(iv) Dry sweeping and dry mopping prohibited.

(e) *Signs, information and training.*—(1) *Signs.* (i) Entrances to regulated areas shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT

AUTHORIZED PERSONNEL ONLY

(ii) Entrances to regulated areas containing operations covered in paragraph (c)(5) of this section shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT
EXPOSED IN THIS AREA

IMPERVIOUS SUIT INCLUDING GLOVES, BOOTS, AND AIR-SUPPLIED HOOD REQUIRED AT ALL TIMES

AUTHORIZED PERSONNEL ONLY

(iii) Appropriate signs and instructions shall be posted at the entrance to, and exit from, regulated areas, informing employees of the procedures that must be followed in entering and leaving a regulated area.

(2) *Container contents identification.* (i) Containers of 4-Nitrobiphenyl and containers required under paragraphs (c)(4)(v) and (c)(6)(vii)(*b*), and (c)(6)(viii)(*b*) of this section which are accessible only to, and handled only by, authorized employees, or by other employees trained in accordance with subparagraph (5) of this paragraph, may have contents identification limited to a generic or proprietary name, or other proprietary identification, of the carcinogen and percent.

(ii) Containers of 4-Nitrobiphenyl and containers required under paragraphs (c)(4)(v), (c)(6)(vii)(*b*), and (c)(6)(viii)(*b*) of this section which are accessible to, or handled by employees other than authorized employees or employees trained in accordance with subparagraph (5) of this paragraph shall have contents identification which includes the full chemical name and Chemical Abstracts Service Registry number as listed in paragraph (a)(1) of this section.

(iii) Containers shall have the warning words "CANCER-SUSPECT AGENT" displayed immediately under or adjacent to the contents identification.

(iv) Containers which have 4-Nitrobiphenyl contents with corrosive or irritating properties shall have label statements warning of such hazards, noting, if appropriate, particularly sensitive or affected portions of the body.

(3) *Lettering.* Lettering on signs and instructions required by subparagraph (1) shall be a minimum letter height of 2 inches. Labels on containers required under this section shall not be less than ½ the size of the largest lettering on the package, and not less than 8 point type in any instance; *Provided,* That no such required lettering need be more than 1 inch in height.

(4) *Prohibited statements.* No statement shall appear on or near any required sign, label, or instruction which contradicts or detracts from the effect of any required warning, information or instruction.

(5) *Training and indoctrination.* (i) Each employee prior to being authorized to enter a regulated area, shall receive a training and indoctrination program including, but not necessarily limited to:

(*a*) The nature of the carcinogenic hazards of 4-Nitrobiphenyl, including local and systemic toxicity;

(*b*) The specific nature of the operation involving 4-Nitrobiphenyl which could result in exposure;

(*c*) The purpose for and application of the medical surveillance program, including, as appropriate, methods of self-examination;

(*d*) The purpose for and application of decontamination practices and purposes;

(*e*) The purpose for and significance of emergency practices and procedures;

(*f*) The employee's specific role in emergency procedures;

(*g*) Specific information to aid the employee in recognition and evaluation of conditions and situations which may result in the release of 4-Nitrobiphenyl;

(*h*) The purpose for and application of specific first aid procedures and practices;

(*i*) A review of this section at the employee's first training and indoctrination program and annually thereafter.

(ii) Specific emergency procedures shall be prescribed, and posted, and employees shall be familiarized with their terms, and rehearsed in their application.

(iii) All materials relating to the program shall be provided upon request to authorized representatives of the Assistant Secretary and the Director.

(f) *Reports.*—(1) *Operations.* Not later than March 1, 1974, the information required in subparagraphs (i), (ii), (iii), and (iv) of this paragraph shall be reported in writing to the nearest OSHA Area Director. Any changes in such information shall be similarly reported in writing within 15 calendar days of such change.

(i) A brief description and in-plant location of the area(s) regulated and the address of each regulated area;

(ii) The name(s) and other identifying information as to the presence of

4-Nitrobiphenyl in each regulated area;

(iii) The number of employees in each regulated area, during normal operations including maintenance activities; and

(iv) The manner in which 4-Nitrobiphenyl is present in each regulated area; e.g. whether it is manufactured, processed, used, repackaged, released, stored, or otherwise handled.

(2) *Incidents.* Incidents which result in the release of 4-Nitrobiphenyl into any area where employees may be potentially exposed shall be reported in accordance with this subparagraph.

(i) A report of the occurrence of the incident and the facts obtainable at that time including a report on any medical treatment of affected employees shall be made within 24 hours to the nearest OSHA Area Director.

(ii) A written report shall be filed with the nearest OSHA Area Director within 15 calendar days thereafter and shall include:

(*a*) A specification of the amount of material released, the amount of time involved, and an explanation of the procedure used in determining this figure;

(*b*) A description of the area involved, and the extent of known and possible employee exposure and area contamination; and

(*c*) A report of any medical treatment of affected employees, and any medical surveillance program implemented; and

(*d*) An analysis of the circumstances of the incident, and measures taken or to be taken, with specific completion dates, to avoid further similar releases.

(g) *Medical surveillance.* At no cost to the employee, a program of medical surveillance shall be established and implemented for employees considered for assignment to enter regulated areas, and for authorized employees.

(1) *Examinations.* (i) Before an employee is assigned to enter a regulated area, a preassignment physical examination by a physician shall be provided. The examination shall include the personal history of the employee, family and occupational background, including genetic and environmental factors.

(ii) Authorized employees shall be provided periodic physical examinations, not less often than annually, following the preassignment examination.

(iii) In all physical examinations, the examining physician shall consider whether there exist conditions of increased risk, including reduced immunological competence, those undergoing treatment with steroids or cytotoxic agents, pregnancy and cigarette smoking.

(2) *Records.* (i) Employers of employees examined pursuant to this paragraph shall cause to be maintained complete and accurate records of all such medical examinations. Records shall be maintained for the duration of the employee's employment. Upon termination of the employee's employment, including retirement or death, or in the event that the employer ceases business without a successor, records, or notarized true copies thereof, shall be forwarded by registered mail to the Director.

(ii) Records required by this paragraph shall be provided upon request to authorized representatives of the Assistant Secretary or the Director; and upon request of an employee or former employee, to a physician designated by the employee or to a new employer.

(iii) Any physician who conducts a medical examination required by this paragraph shall furnish to the employer a statement of the employee's suitability for employment in the specific exposure.

### § 1910.1004 Alpha-Naphthylamine

(a) *Scope and application.* (1) This section applies to any area in which alpha-Naphthylamine, Chemical Abstracts Service Registry Number 134327 is manufactured, processed, repackaged, released, handled, or stored, but shall not apply to trans-shipment in sealed containers, except for the labeling requirements under paragraphs (e) (2), (3), and (4) of this section.

(2) This section shall not apply to solid or liquid mixtures containing less than 1.0 percent by weight or volume of alpha-Naphthylamine.

(3) This section will not apply to operations involving the destructive distillation of carbonaceous materials, such as occurs in coke ovens.

(b) *Definitions.* For the purposes of this section:

(1) "Absolute filter" is one capable of retaining 99.97 percent of a mono disperse aerosol of 0.3 $\mu$m particles.

(2) "Authorized employee" means an employee whose duties require him to be in the regulated area and who has been specifically assigned by the employer.

(3) "Clean change room" means a room where employees put on clean clothing and/or protective equipment in an environment free of alpha-Naphthylamine. The clean change room shall be contiguous to and have an entry from a shower room, when the shower room facilities are otherwise required in this section.

(4) "Closed system" means an operation involving alpha-Naphthylamine where containment prevents the release of alpha-Naphthylamine into regulated areas, nonregulated areas, or the external environment.

(5) "Decontamination" means the inactivation of alpha-Naphthylamine or its safe disposal.

(6) "Director" means the Director, National Institute for Occupational Safety and Health, or any person directed by him or the Secretary of Health, Education, and Welfare to act for the Director.

(7) "Disposal" means the safe removal of alpha-Naphthylamine from the work environment.

(8) "Emergency" means an unforeseen circumstance or set of circumstances resulting in the release of alpha-Naphthylamine which may result in exposure to or contact with alpha-Naphthylamine.

(9) "External environment" means any environment external to regulated and nonregulated areas.

(10) "Isolated system" means a fully enclosed structure other than the vessel of containment of alpha-Naphthylamine, which is impervious to the passage of alpha-Naphthylamine, and which would prevent the entry of alpha-Naphthylamine into regulated areas, nonregulated areas, or the external environment, should leakage or spillage from the vessel of containment occur.

(11) "Laboratory type hood" is a device enclosed on three sides and the top and bottom, designed and maintained so as to draw air inward at an average linear face velocity of 150 feet per minute with a minimum of 125 feet per minute; designed, constructed, and maintained in such a way that an operation involving alpha-Naphthylamine within the hood does not require the insertion of any portion of any employee's body other than his hands and arms.

(12) "Nonregulated area" means any area under the control of the employer where entry and exit is neither restricted nor controlled.

(13) "Open-vessel system" means an operation involving alpha-Naphthylamine in an open vessel, which is not in an isolated system, a laboratory type hood, nor in any other system affording equivalent protection against the entry of alpha-Naphthylamine into regulated areas, nonregulated areas, or the external environment.

(14) "Protective clothing" means clothing designed to protect an employee against contact with or exposure to alpha-Naphthylamine.

(15) "Regulated area" means an area where entry and exit is restricted and controlled.

(c) *Requirements for areas containing alpha-Naphthylamine.* A regulated area shall be established by an employer where alpha-Naphthylamine is manufactured, processed, used, repackaged, released, handled or stored. All such areas shall be controlled in accordance with the requirements for

the following category or categories describing the operation involved:

(1) *Isolated systems.* Employees working with alpha-Naphthylamine within an isolated system, such as a "glove box" shall wash their hands and arms upon completion of the assigned task and before engaging in other activities not associated with the isolated system.

(2) *Closed system operation.* Within regulated areas where alpha-Naphthylamine is stored in sealed containers, or contained in a closed system, including piping systems, with any sample ports or openings closed while alpha-Naphthylamine is contained within:

(i) Access shall be restricted to authorized employees only;

(ii) Employees shall be required to wash hands, forearms, face and neck upon each exit from the regulated areas, close to the point of exit and before engaging in other activities.

(3) *Open vessel system operations.* Open vessel system operations as defined in paragraph (b)(13) of this section are prohibited.

(4) *Transfer from a closed system, charging or discharging point operations, or otherwise opening a closed system.* In operations involving "laboratory type hoods," or in locations where alpha-Naphthylamine is contained in an otherwise "closed system," but is transferred, charged, or discharged into other normally closed containers, the provisions of this subparagraph shall apply.

(i) Access shall be restricted to authorized employees only;

(ii) Each operation shall be provided with continuous local exhaust ventilation so that air movement is always from ordinary work areas to the operation. Exhaust air shall not be discharged to regulated areas, nonregulated areas or the external environment unless decontaminated. Clean makeup air shall be introduced in sufficient volume to maintain the correct operation of the local exhaust system.

(iii) Employees shall be provided with, and required to wear, clean, full body protective clothing (smocks, coveralls, or long-sleeved shirt and pants), and shoe covers and gloves prior to entering a regulated area.

(iv) Employees engaged in alpha-Naphthylamine handling operations shall be provided with and required to wear and use a half-face, filter-type respirator for dusts, mists, and fumes, in accordance with § 1910.134. A respirator affording higher levels of protection may be substituted.

(v) Prior to each exit from a regulated area, employees shall be required to remove and leave protective clothing and equipment at the point of exit and at the last exist of the day, to place used clothing and equipment in impervious containers at the point of exit for purposes of decontamination or disposal. The contents of such impervious containers shall be identified, as required under paragraphs (e) (2), (3), and (4) of this section.

(vi) Employees shall be required to wash hands, forearms, face and neck on each exit from the regulated area, close to the point of exit, and before engaging in other activities.

(vii) Employees shall be required to shower after the last exit of the day.

(viii) Drinking fountains are prohibited in the regulated area.

(5) *Maintenance and decontamination activities.* In cleanup of leaks or spills, maintenance or repair operations on contaminated systems or equipment, or any operations involving work in an area where direct contact with alpha-Naphthylamine could result, each authorized employee entering that area shall:

(i) Be provided with and required to wear clean, impervious garments, including gloves, boots and continuous-air supplied hood in accordance with § 1910.134.

(ii) Be decontaminated before removing the protective garments and hood.

(iii) Be required to shower upon removing the protective garments and hood.

(6) *Laboratory activities.* [Deleted]

(d) *General regulated area requirements*—(1) *Employee identification.* A daily roster of employees entering regulated areas shall be established and maintained. The rosters or a summary of the rosters, shall be retained for a period of 20 years. The rosters and/or summaries shall be provided upon request to authorized representatives of the Assistant Secretary and the Director. In the event that the employer ceases business without a successor, rosters shall be forwarded by registered mail to the Director.

(2) *Emergencies.* In an emergency, immediate measures including, but not limited to, the requirements of subdivisions (i), (ii), (iii), (iv), and (v) of this paragraph shall be implemented.

(i) The potentially affected area shall be evacuated as soon as the emergency has been determined.

(ii) Hazardous conditions created by the emergency shall be eliminated and the potentially affected area shall be decontaminated prior to the resumption of normal operations.

(iii) Special medical surveillance by a physician shall be instituted within 24 hours for employees present in the potentially affected area at the time of the emergency. A report of the medical surveillance and any treatment shall be included in the incident report, in accordance with paragraph (f)(2) of this section.

(iv) Where an employee has a known contact with alpha-Naphthylamine, such employee shall be required to shower as soon as possible, unless contraindicated by physical injuries.

(v) An incident report on the emergency shall be reported as provided in paragraph (f)(2) of this section.

(3) *Hygiene facilities and practices.* (i) Storage or consumption of food, storage or use of containers of beverages, storage or application of cosmetics, smoking, storage of smoking materials, tobacco products or other products for chewing, or the chewing of such products, are prohibited in regulated areas.

(ii) Where employees are required by this section to wash, washing facilities shall be provided in accordance with § 1910.141(d) (1) and (2) (ii) through (vii).

(iii) Where employees are required by this section to shower, shower facilities shall be provided in accordance with § 1910.141(d)(3).

(iv) Where employees wear protective clothing and equipment clean change rooms shall be provided, in accordance with § 1910.141(e), for the number of such employees required to change clothes.

(v) Where toilets are in regulated areas, such toilets shall be in a separate room.

(4) *Contamination control.* (i) Regulated areas, except for outdoor systems, shall be maintained under pressure negative with respect to nonregulated areas. Local exhaust ventilation may be used to satisfy this requirement. Clean makeup air in equal volume shall replace air removed.

(ii) Any equipment, material, or other item taken into or removed from a regulated area shall be done so in a manner that does not cause contamination in nonregulated areas or the external environment.

(iii) Decontamination procedures shall be established and implemented to remove alpha-Naphthylamine from the surfaces of materials, equipment and the decontamination facility.

(iv) Dry sweeping and dry mopping are prohibited.

(e) *Signs, information and training.* (1) *Signs.* (i) Entrances to regulated areas shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT

AUTHORIZED PERSONNEL ONLY

(ii) Entrances to regulated areas containing operations covered in paragraph (c)(5) of this section shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT EXPOSED IN THIS AREA

IMPERVIOUS SUIT INCLUDING GLOVES, BOOTS, AND AIR-SUPPLIED HOOD REQUIRED AT ALL TIMES

AUTHORIZED PERSONNEL ONLY

(iii) Appropriate signs and instructions shall be posted at the entrance to, and exit from, regulated areas, informing employees of the procedures that must be followed in entering and leaving a regulated area.

(2) *Container contents identification.* (i) Containers of alpha-Naphthylamine and containers required under paragraphs (c)(4)(v) and (c)(6)(vii)(*b*), and (c)(6)(viii)(*b*) of this section which are accessible only to, and handled only by, authorized employees, or by other employees trained in accordance with subparagraph (5) of this paragraph, may have contents identification limited to a generic or proprietary name, or other proprietary identification, of the carcinogen and percent.

(ii) Containers of alpha-Naphthylamine and containers required under paragraphs (c)(4)(v), (c)(6)(vii)(*b*), and (c)(6)(viii)(*b*) of this section which are accessible to, or handled by employees other than authorized employees or employees trained in accordance with subparagraph (5) of this paragraph shall have contents identification which includes the full chemical name and Chemical Abstracts Service Registry number as listed in paragraph (a)(1) of this section.

(iii) Containers shall have the warning words "CANCER-SUSPECT AGENT" displayed immediately under or adjacent to the contents identification.

(iv) Containers which have alpha-Naphthylamine contents with corrosive or irritating properties shall have label statements warning of such hazards, noting, if appropriate, particularly sensitive or affected portions of the body.

(3) *Lettering.* Lettering on signs and instructions required by subparagraph (1) shall be a minimum letter height of 2 inches. Labels on containers required under this section shall not be less than ½ the size of the largest lettering on the package, and not less than 8 point type in any instance; provided that no such required lettering need be more than 1 inch in height.

(4) *Prohibited statements.* No statement shall appear on or near any required sign, label, or instruction which contradicts or detracts from the effect of any required warning, information or instruction.

(5) *Training and indoctrination.* (i) Each employee prior to being authorized to enter a regulated area, shall receive a training and indoctrination program including, but not necessarily limited to: (*a*) The nature of the carcinogenic hazards of alpha-Naphthylamine, including local and systemic toxicity;

(*b*) The specific nature of the operation involving alpha-Naphthylamine which could result in exposure;

(*c*) The purpose for the application of the medical surveillance program, including, as appropriate, methods of self-examination;

(*d*) The purpose for and application of decontamination practices and purposes;

(*e*) The purpose for and significance of emergency practices and procedures;

(*f*) The employee's specific role in emergency procedures;

(*g*) Specific information to aid the employee in recognition and evaluation of conditions and situations which may result in the release of alpha-Naphthylamine;

(*h*) The purpose for and application of specific first aid procedures and practices;

(*i*) A review of this section at the employee's first training and indoctrination program and annually thereafter.

(ii) Specific emergency procedures shall be prescribed, and posted, and employees shall be familiarized with their terms, and rehearsed in their application.

(iii) All materials relating to the program shall be provided upon request to authorized representatives of the Assistant Secretary and the Director.

(f) *Reports*—(1) *Operations.* Not later than March 1, 1974, the information required in subparagraphs (i), (ii), (iii), and (iv) of this paragraph shall be reported in writing to the nearest OSHA Area Director. Any changes in such information shall be similarly reported in writing within 15 calendar days of such change. (i) A brief description and in-plant location of the area(s) regulated and the address of each regulated area;

(ii) The name(s) and other identifying information as to the presence of alpha-Naphthylamine in each regulated area;

(iii) The number of employees in each regulated area, during normal operations including maintenance activities; and

(iv) The manner in which alpha-Naphthylamine is present in each regulated area; e.g. whether it is manufactured, processed, used, repackaged, released, stored, or otherwise handled.

(2) *Incidents.* Incidents which result in the release of alpha-Naphthylamine into any area where employees may be potentially exposed shall be reported in accordance with this subparagraph.

(i) A report of the occurrence of the incident and the facts obtainable at that time including a report on any medical treatment of affected employees shall be made within 24 hours to the nearest OSHA Area Director.

(ii) A written report shall be filed with the nearest OSHA Area Director within 15 calendar days thereafter and shall include:

(*a*) A specification of the amount of material released, the amount of time involved, and an explanation of the procedure used in determining this figure;

(*b*) A description of the area involved, and the extent of known and possible employee exposure and area contamination; and

(*c*) A report of any medical treatment of affected employees, and any medical surveillance program implemented; and

(*d*) An analysis of the circumstances of the incident, and measures taken or to be taken, with specific completion dates, to avoid further similar releases.

(g) *Medical surveillance.* At no cost to the employee, a program of medical surveillance shall be established and implemented for employees considered for assignment to enter regulated areas, and for authorized employees.

(1) *Examinations.* (i) Before an employee is assigned to enter a regulated area, a preassignment physical examination by a physician shall be provided. The examination shall include the personal history of the employee, family and occupational background, including genetic and environmental factors.

(ii) Authorized employees shall be provided periodic physical examinations, not less often than annually, following the preassignment examination.

(iii) In all physical examinations, the examining physician shall consider whether there exist conditions of increased risk, including reduced immunological competence, those undergoing treatment with steroids or cytotoxic agents, pregnancy and cigarette smoking.

(2) *Records.* (i) Employers of employees examined pursuant to this paragraph shall cause to be maintained complete and accurate records of all such medical examinations. Records shall be maintained for the duration of the employee's employment. Upon termination of the employee's employment, including retirement or death, or in the event that the employer ceases business without a successor, records, or notarized true copies thereof, shall be forwarded by registered mail to the Director.

(ii) Records required by this paragraph shall be provided upon request to authorized representatives of the Assistant Secretary or the Director; and upon request of an employee or former employee, to a physician desig-

nated by the employee or to a new employer.

(iii) Any physician who conducts a medical examination required by this paragraph shall furnish to the employer a statement of the employee's suitability for employment in the specific exposure.

**§ 1910.1006 Methyl chloromethyl ether.**

(a) *Scope and application.* (1) This section applies to any area in which methyl chloromethyl ether, Chemical Abstracts Service Registry Number 107302 is manufactured, processed, repackaged, released, handled, or stored, but shall not apply to trans-shipment in sealed containers, except for the labeling requirements under paragraphs (e)(2), (3), and (4) of this section.

(2) This section shall not apply to solid or liquid mixtures containing less than 0.1 percent by weight or volume of methyl chloromethyl ether.

(b) *Definitions.* For the purposes of this section: (1) "Absolute filter" is one capable of retaining 99.97 percent of a mono disperse aerosol of 0.3 $\mu$m particles.

(2) "Authorized employee" means an employee whose duties require him to be in the regulated area and who has been specifically assigned by the employer.

(3) "Clean change room" means a room where employees put on clean clothing and/or protective equipment in an environment free of methyl chloromethyl ether. The clean change room shall be contiguous to and have an entry from a shower room, when the shower room facilities are otherwise required in this section.

(4) "Closed system" means an operation involving methyl chloromethyl ether where containment prevents the release of methyl chloromethyl ether into regulated areas, nonregulated areas, or the external environment.

(5) "Decontamination" means the inactivation of methyl chloromethyl ether or its safe disposal.

(6) "Director" means the Director, National Institute for Occupational Safety and Health, or any person directed by him or the Secretary of Health, Education, and Welfare to act for the Director.

(7) "Disposal" means the safe removal of methyl chloromethyl ether from the work environment.

(8) "Emergency" means an unforeseen circumstance or set of circumstances resulting in the release of methyl chloromethyl ether which may result in exposure to or contact with methyl chloromethyl ether.

(9) "External environment" means any environment external to regulated and nonregulated areas.

(10) "Isolated system" means a fully enclosed structure other than the vessel of containment of methyl chloromethyl ether, which is impervious to the passage of methyl chloromethyl ether, and which would prevent the entry of methyl chloromethyl ether into regulated areas, nonregulated areas, or the external environment, should leakage or spillage from the vessel of containment occur.

(11) "Laboratory type hood" is a device enclosed on three sides and the top and bottom, designed and maintained so as to draw air inward at an average linear face velocity of 150 feet per minute with a minimum of 125 feet per minute; designed, constructed, and maintained in such a way that an operation involving methyl chloromethyl ether within the hood does not require the insertion of any portion of any employee's body other than his hands and arms.

(12) "Nonregulated area" means any area under the control of the employer where entry and exit is neither restricted nor controlled.

(13) "Open-vessel system" means an operation involving methyl chloromethyl ether in an open vessel, which is not in an isolated system, a laboratory type hood, nor in any other system affording equivalent protection against the entry of methyl chloromethyl ether into regulated areas, nonregulated areas, or the external environment.

(14) "Protective clothing" means clothing designed to protect an employee against contact with or exposure to methyl chloromethyl ether.

(15) "Regulated area" means an area where entry and exit is restricted and controlled.

(c) *Requirements for areas containing methyl chloromethyl ether.* A regulated area shall be established by an employer where methyl chloromethyl ether is manufactured, processed, used, repackaged, released, handled or stored. All such areas shall be controlled in accordance with the requirements for the following category or categories describing the operation involved:

(1) *Isolated systems.* Employees working with methyl chloromethyl ether within an isolated system, such as a "glove box" shall wash their hands and arms upon completion of the assigned task and before engaging in other activities not associated with the isolated system.

(2) *Closed system operation.* Within regulated areas where methyl chloromethyl ether is stored in sealed containers, or contained in a closed system, including piping systems, with any sample ports or openings closed while methyl chloromethyl ether is contained within. Access shall be restricted to authorized employees only.

(3) *Open vessel system operations.* Open vessel system operations as defined in paragraph (b)(13) of this section are prohibited.

(4) *Transfer from a closed system, charging or discharging point operations, or otherwise opening a closed system.* In operations involving "laboratory type hoods," or in locations where methyl chloromethyl ether is contained in an otherwise "closed system," but is transferred, charged, or discharged into other normally closed containers, the provisions of this subparagraph shall apply. (i) Access shall be restricted to authorized employees only;

(ii) Each operation shall be provided with continuous local exhaust ventilation so that air movement is always from ordinary work areas to the operation. Exhaust air shall not be discharged to regulated areas, nonregulated areas or the external environment unless decontaminated. Clean makeup air shall be introduced in sufficient volume to maintain the correct operation of the local exhaust system.

(iii) Employees shall be provided with, and required to wear, clean, full body protective clothing (smocks, coveralls, or long-sleeved shirt and pants), and gloves prior to entering the regulated area.

(iv) Employees engaged in methyl chloromethyl ether handling operations shall be provided with and required to wear and use a full-face, supplied air respirator, of the continuous flow or pressure-demand type, in accordance with § 1910.124.

(v) Prior to each exit from a regulated area, employees shall be required to remove and leave protective clothing and equipment at the point of exit and at the last exit of the day, to place used clothing and equipment in impervious containers at the point of exit for purposes of decontamination or disposal. The contents of such impervious containers shall be identified, as required under paragraphs (e)(2), (3), and (4) of this section.

(vi) Drinking fountains are prohibited in the regulated area.

(5) *Maintenance and decontamination activities.* In cleanup of leaks or spills, maintenance or repair operations on contaminated systems or equipment, or any operations involving work in an area where direct contact with methyl chloromethyl ether could result, each authorized employee entering that area shall: (i) Be provided with and required to wear clean, impervious garments, including gloves, boots and continuous-air supplied hood in accordance with § 1910.134.

(ii) Be decontaminated before removing the protective garments and hood;

(iii) Be required to shower upon removing the protective garments and hood.

(d) *General regulated area requirements*—(1) *Employee identification.* A daily roster of employees entering regulated areas shall be established and maintained. The rosters or a summary of the rosters, shall be retained for a period of 20 years. The rosters and/or summaries shall be provided upon request to authorized representatives of the Assistant Secretary and the Director. In the event that the employer ceases business without a successor, rosters shall be forwarded by registered mail to the Director.

(2) *Emergencies.* In an emergency, immediate measures including, but not limited to, the requirements of subdivisions (i), (ii), (iii), (iv), and (v) of this paragraph shall be implemented.

(i) The potentially affected area shall be evacuated as soon as the emergency has been determined.

(ii) Hazardous conditions created by the emergency shall be eliminated and the potentially affected area shall be decontaminated prior to the resumption of normal operations.

(iii) Special medical surveillance by a physician shall be instituted within 24 hours for employees present in the potentially affected area at the time of the emergency. A report of the medical surveillance and any treatment shall be included in the incident report, in accordance with paragraph (f)(2) of this section.

(iv) Where an employee has a known contact with methyl chloromethyl ether, such employee shall be required to shower as soon as possible, unless contraindicated by physical injuries.

(v) An incident report on the emergency shall be reported as provided in paragraph (f)(2) of this section.

(3) *Hygiene facilities and practices.* (i) Storage or consumption of food, storage or use of containers of beverages, storage or application of cosmetics, smoking, storage of smoking materials, tobacco products or other products for chewing, or the chewing of such products, are prohibited in regulated areas.

(ii) Where employees wear protective clothing and equipment, clean change rooms shall be provided, in accordance with § 1910.141(e), for the number of such employees required to change clothes.

(iii) Where toilets are in regulated areas, such toilets shall be in a separate room.

(iv) Where employees are required by this section to wash, washing facilities shall be provided in accordance with § 1910.141(d) (1) and (2) (ii) through (vii).

(v) Where employees are required by this section to shower, shower facilities shall be provided in accordance with § 1910.141(d)(3).

(4) *Contamination control.* (i) Regulated areas, except for outdoor systems, shall be maintained under pressure negative with respect to nonregulated areas. Local exhaust ventilation may be used to satisfy this requirement. Clean makeup air in equal volume shall replace air removed.

(ii) Any equipment, material, or other item taken into or removed from a regulated area shall be done so in a manner that does not cause contamination in nonregulated areas or the external environment.

(iii) Decontamination procedures shall be established and implemented to remove methyl chloromethyl ether from the surfaces of materials, equipment and the decontamination facility.

(e) *Signs, information and training.* (1) *Signs.* (i) Entrances to regulated areas shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT

AUTHORIZED PERSONNEL ONLY

(ii) Entrances to regulated areas containing operations covered in paragraph (c)(5) of this section shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT
EXPOSED IN THIS AREA

IMPERVIOUS SUIT INCLUDING GLOVES, BOOTS, AND AIR-SUPPLIED HOOD REQUIRED AT ALL TIMES

AUTHORIZED PERSONNEL ONLY

(iii) Appropriate signs and instructions shall be posted at the entrance to, and exit from, regulated areas, informing employees of the procedures that must be followed in entering and leaving a regulated area.

(2) *Container contents identification.* (i) Containers of methyl chloromethyl ether and containers required under paragraphs (c)(4)(v) and (c)(6)(vii)(*b*), and (c)(6)(viii)(*b*) of this section which are accessible only to, and handled only by, authorized employees, or by other employees trained in accordance with subparagraph (5) of this paragraph may have contents identification limited to a generic or proprietary name, or other proprietary identification, of the carcinogen and percent.

(ii) Containers of methyl chloromethyl ether and containers required under paragraphs (c)(4)(v), (c)(6)(vii)(*b*), and (c)(6)(viii)(*b*) of this section which are accessible to, or handled by, employees other than authorized employees or employees trained in accordance with subparagraph (5) of this paragraph shall have contents identification which includes the full chemical name and Chemical Abstracts Service Registry number as listed in paragraph (a)(1) of this section.

(iii) Containers shall have the warning words "CANCER-SUSPECT AGENT" displayed immediately under or adjacent to the contents identification.

(iv) Containers which have methyl chloromethyl ether contents with corrosive or irritating properties shall have label statements warning of such hazards, noting, if appropriate, particularly sensitive or affected portions of the body.

(3) *Lettering.* Lettering on signs and instructions required by subparagraph (1) shall be a minimum letter height of 2 inches. Labels on containers required under this section shall not be less than ½ the size of the largest lettering on the package, and not less than 8 point type in any instance; *provided* that no such required lettering need be more than 1 inch in height.

(4) *Prohibited statements.* No statement shall appear on or near any required sign, label, or instruction which contradicts or detracts from the effect of any required warning, information or instruction.

(5) *Training and indoctrination.* (i) Each employee prior to being authorized to enter a regulated area, shall receive a training and indoctrination program including, but not necessarily limited to:

(*a*) The nature of the carcinogenic hazards of methyl chloromethyl ether, including local and systemic toxicity;

(*b*) The specific nature of the operation involving methyl chloromethyl ether which could result in exposure;

(*c*) The purpose for and application of the medical surveillance program, including, as appropriate, methods of self-examination;

(*d*) The purpose for and application of decontamination practices and purposes;

(*e*) The purpose for and significance of emergency practices and procedures;

(*f*) The employee's specific role in emergency procedures;

(*g*) Specific information to aid the employee in recognition and evaluation of conditions and situations which may result in the release of methyl chloromethyl ether;

(*h*) The purpose for and application of specific first aid procedures and practices;

(*i*) A review of this section at the employee's first training and indoctrination program and annually thereafter.

(ii) Specific emergency procedures shall be prescribed, and posted, and employees shall be familiarized with their terms, and rehearsed in their application.

(iii) All materials relating to the program shall be provided upon request to authorized representatives of the Assistant Secretary and the Director.

(f) *Reports*—(1) *Operations.* Not later than March 1, 1974, the information required in paragraphs (i), (ii), (iii), and (iv) of this paragraph shall be reported in writing to the nearest OSHA Area Director. Any changes in such information shall be similarly reported in writing within 15 calendar days of such change.

(i) A brief description and in-plant location of the area(s) regulated and the address of each regulated area;

(ii) The name(s) and other identifying information as to the presence of methyl chloromethyl ether in each regulated area;

(iii) The number of employees in each regulated area, during normal operations including maintenance activities; and

(iv) The manner in which methyl chloromethyl ether is present in each regulated area; e.g. whether it is manufactured, processed, used, repackaged, released, stored, or otherwise handled.

(2) *Incidents.* Incidents which result in the release of methyl chloromethyl ether into any area where employees may be potentially exposed shall be reported in accordance with this subparagraph.

(i) A report of the occurrence of the incident and the facts obtainable at that time including a report on any medical treatment of affected employees shall be made within 24 hours to the nearest OSHA Area Director.

(ii) A written report shall be filed with the nearest OSHA Area Director within 15 calendar days thereafter and shall include:

(*a*) A specification of the amount of material released, the amount of time involved, and an explanation of the procedure used in determining this figure;

(*b*) A description of the area involved, and the extent of known and possible employee exposure and area contamination; and

(*c*) A report of any medical treatment of affected employees, and any medical surveillance program implemented; and

(*d*) An analysis of the circumstances be taken, with specific completion dates, of the incident, and measures taken or to avoid further similar releases.

(g) *Medical surveillance.* At no cost to the employee, a program of medical surveillance shall be established and implemented for employees considered for assignment to enter regulated areas, and for authorized employees.

(1) *Examinations.* (i) Before an employee is assigned to enter a regulated area, a preassignment physical examination by a physician shall be provided. The examination shall include the personal history of the employee, family and occupational background, including genetic and environmental factors.

(ii) Authorized employees shall be provided periodic physical examinations, not less often than annually, following the preassignment examination.

(iii) In all physical examinations, the examining physician shall consider whether there exist conditions of increased risk, including reduced immunological competence, those undergoing treatment with steroids or cytotoxic agents, pregnancy and cigarette smoking.

(2) *Records.* (i) Employers of employees examined pursuant to this paragraph shall cause to be maintained complete and accurate records of all such medical examinations. Records shall be maintained for the duration of the employee's employment. Upon termination of the employee's employment, including retirement or death, or in the event that the employer ceases business without a successor, records, or notarized true copies thereof, shall be forwarded by registered mail to the Director.

(ii) Records required by this paragraph shall be provided upon request to authorized representatives of the Assistant Secretary or the Director; and upon request of an employee or former employee, to a physician designated by the employee or to a new employer.

(iii) Any physician who conducts a medical examination required by this paragraph shall furnish to the employer a statement of the employee's suitability for employment in the specific exposure.

### § 1910.1007 3,3'-Dichlorobenzidine (and its salts).

(a) *Scope and application.* (1) This section applies to any area in which 3,3'-Dichlorobenzidine (or its salts), Chemical Abstracts Service Registry Number 91941 is manufactured, processed, repackaged, released, handled, or stored, but shall not apply to transshipment in sealed containers except for the labeling requirements under paragraphs (e)(2), (3), and (4) of this section.

(2) This section shall not apply to solid or liquid mixtures containing less than 1 percent by weight or volume of 3,3'-Dichlorobenzidine (or its salts).

(b) *Definitions.* For the purposes of this section: (1) "Absolute filter" is one capable of retaining 99.97 percent of a mono disperse aerosol of 0.3 $\mu$m particles.

(2) "Authorized employee" means an employee whose duties require him to be in the regulated area and who has been specifically assigned by the employer.

(3) "Clean change room" means a room where employees put on clean clothing and/or protective equipment in an environment free of 3,3'-Dichlorobenzidine (or its salts). The clean change room shall be contiguous to and have an entry from a shower room, when the shower room facilities are otherwise required in this section.

(4) "Closed system" means an operation involving 3,3'-Dichlorobenzidine (or its salts) where containment prevents the release of 3,3'-Dichlorobenzidine (or its salts) into regulated areas, nonregulated areas, or the external environment.

(5) "Decontamination" means the inactivation of 3,3'-Dichlorobenzidine or its safe disposal.

(6) "Director" means the Director, National Institute for Occupational Safety and Health, or any person directed by him or the Secretary of Health, Education, and Welfare to act for the Director.

(7) "Disposal" means the safe removal of 3,3'-Dichlorobenzidine (or its salts) from the work environment.

(8) "Emergency" means an unforeseen circumstance or set of circumstances resulting in the release of 3,3'-Dichlorobenzidine (or its salts) which may result in exposure to or contact with 3,3'-Dichlorobenzidine (or its salts).

(9) "External environment" means any environment external to regulated and nonregulated areas.

(10) "Isolated system" means a fully enclosed structure other than the vessel of containment, of 3,3'-Dichlorobenzidine (or its salts), which is impervious to the passage of 3,3'-Dichlorobenzidine (or its salts) and which would prevent the entry of 3,3'-Dichlorobenzidine (or its salts) into regulated areas, nonregulated areas, or the external environment, should leakage or spillage from the vessel of containment occur.

(11) "Laboratory type hood" is a device enclosed on three sides and the top and bottom, designed and maintained so as to draw air inward at an average linear face velocity of 150 feet per minute with a minimum of 125 feet per minute; designed, constructed, and maintained in such a way that an operation involving 3,3'-Dichlorobenzidine (or its salts) within the hood does not require the insertion of any portion of any employee's body other than his hands and arms.

(12) "Nonregulated area" means any area under the control of the employer where entry and exit is neither restricted nor controlled.

(13) "Open-vessel system" means an operation involving 3,3'-Dichlorobenzidine (or its salts) in an open vessel, which is not in an isolated system, a laboratory type hood, nor in any other system affording equivalent protection against the entry of 3,3'-Dichlorobenzidine (or its salts) into regulated

areas, nonregulated areas, or the external environment.

(14) "Protective clothing" means clothing designed to protect an employee against contact with or exposure to 3,3'-Dichlorobenzidine (or its salts).

(15) "Regulated area" means an area where entry and exit is restricted and controlled.

(c) *Requirements for areas containing 3,3'-Dichlorobenzidine (or its salts).* A regulated area shall be established by an employer where 3,3'-Dichlorobenzidine (or its salts) is manufactured, processed, used, repackaged, released, handled or stored. All such areas shall be controlled in accordance with the requirements for the following category or categories describing the operation involved: (1) *Isolated systems.* Employees working with 3,3'-Dichlorobenzidine (or its salts) within an isolated system, such as a "glove box" shall wash their hands and arms upon completion of the assigned task and before engaging in other activities not associated with the isolated system.

(2) *Closed system operation.* Within regulated areas where 3,3'-Dichlorobenzidine (or its salts) is stored in sealed containers, or contained in a closed system, including piping systems, with any sample ports or openings closed while 3,3'-Dichlorobenzidine (or its salts) is contained within:

(i) Access shall be restricted to authorized employees only;

(ii) Employees shall be required to wash hands, forearms, face and neck upon each exit from the regulated areas, close to the point of exit and before engaging in other activities.

(3) *Open vessel system operations.* Open vessel system operations as defined in paragraph (b)(13) of this section are prohibited.

(4) *Transfer from a closed system, charging or discharging point operations, or otherwise opening a closed system.* In operations involving "laboratory type hoods," or in locations where 3,3'-Dichlorobenzidine (or its salts) is contained in an otherwise "closed system," but is transferred, charged, or discharged into other normally closed containers, the provisions of this subparagraph shall apply.

(i) Access shall be restricted to authorized employees only;

(ii) Each operation shall be provided with continuous local exhaust ventilation so that air movement is always from ordinary work areas to the operation. Exhaust air shall not be discharged to regulated areas, nonregulated areas or the external environment unless decontaminated. Clean makeup air shall be introduced in sufficient volume to maintain the correct operation of the local exhaust system.

(iii) Employees shall be provided with, and required to wear, clean, full body protective clothing (smocks, coveralls, or long-sleeved shirt and pants), shoe covers and gloves prior to entering the regulated area.

(iv) Employees engaged in 3,3'-Dichlorobenzidine (or its salts) handling operations shall be provided with and required to wear and use a half-face, filter-type respirator for dusts, mists, and fumes, in accordance with § 1910.134. A respirator affording higher levels of protection may be substituted.

(v) Prior to each exit from a regulated area, employees shall be required to remove and leave protective clothing and equipment at the point of exit and at the last exit of the day, to place used clothing and equipment in impervious containers at the point of exit for purposes of decontamination or disposal. The contents of such impervious containers shall be identified, as required under paragraphs (e) (2), (3), and (4) of this section.

(vi) Employees shall be required to wash hands, forearms, face and neck on each exit from the regulated area, close to the point of exit, and before engaging in other activities.

(vii) Employees shall be required to shower after the last exit of the day.

(viii) Drinking fountains are prohibited in the regulated area.

(5) *Maintenance and decontamination activities.* In cleanup of leaks or spills, maintenance or repair operations on contaminated systems or equipment, or any operations involving work in an area where direct contact with 3,3'-Dichlorobenzidine (or its salts) could result, each authorized employee entering that area shall:

(i) Be provided with and required to wear clean, impervious garments, including gloves, boots and continuous-air supplied hood in accordance with § 1910.134.

(ii) Be decontaminated before removing the protective garments and hood;

(iii) Be required to shower upon removing the protective garments and hood.

(6) *Laboratory activities.* [Deleted]

(d) *General regulated area requirements*—(1) *Employee identification.* A daily roster of employees entering regulated areas shall be established and maintained. The rosters or a summary of the rosters, shall be retained for a period of 20 years. The rosters and/or summaries shall be provided upon request to authorized representatives of the Assistant Secretary and the Director. In the event that the employer ceases business without a successor, rosters shall be forwarded by registered mail to the Director.

(2) *Emergencies.* In an emergency, immediate measures including, but not limited to, the requirements of subdivisions (i), (ii), (iii), (iv), and (v) of this paragraph shall be implemented.

(i) The potentially affected area shall be evacuated as soon as the emergency has been determined.

(ii) Hazardous conditions created by the emergency shall be eliminated and the potentially affected area shall be decontaminated prior to the resumption of normal operations.

(iii) Special medical surveillance by a physician shall be instituted within 24 hours for employees present in the potentially affected area at the time of the emergency. A report of the medical surveillance and any treatment shall be included in the incident report, in accordance with paragraph (f)(2) of this section.

(iv) Where an employee has a known contact with 3,3'-Dichlorobenzidine (or its salts), such employee shall be required to shower as soon as possible, unless contraindicated by physical injuries.

(v) An incident report on the emergency shall be reported as provided in paragraph (f)(2) of this section.

(3) *Hygiene facilities and practices.* (i) Storage or consumption of food, storage or use of containers of beverages, storage or application of cosmetics, smoking, storage of smoking materials, tobacco products or other products for chewing, or the chewing of such products, are prohibited in regulated areas.

(ii) Where employees are required by this section to wash, washing facilities shall be provided in accordance with § 1910.141(d)(1) and (2)(ii) through (vii).

(iii) Where employees are required by this section to shower, shower facilities shall be provided in accordance with § 1910.141(d)(3).

(iv) Where employees wear protective clothing and equipment clean change rooms shall be provided, in accordance with § 1910.141(e), for the number of such employees required to change clothes.

(v) Where toilets are in regulated areas, such toilets shall be in a separate room.

(4) *Contamination control.* (i) Regulated areas, except for outdoor systems, shall be maintained under pressure negative with respect to nonregulated areas. Local exhaust ventilation may be used to satisfy this requirement. Clean makeup air in equal volume shall replace air removed.

(ii) Any equipment, material, or other item taken into or removed from a regulated area shall be done so in a manner that does not cause contamination in nonregulated areas or the external environment.

(iii) Decontamination procedures shall be established and implemented to remove 3,3'-Dichlorobenzidine (or

its salts) from the surfaces of materials, equipment and the decontamination facility.

(iv) Dry sweeping and dry mopping are prohibited.

(e) *Signs, information and training*—(1) *Signs.* (i) Entrances to regulated areas shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT

AUTHORIZED PERSONNEL ONLY

(ii) Entrances to regulated areas containing operations covered in paragraph (c)(5) of this section shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT EXPOSED IN THIS AREA

IMPERVIOUS SUIT INCLUDING GLOVES, BOOTS, AND AIR-SUPPLIED HOOD REQUIRED AT ALL TIMES

AUTHORIZED PERSONNEL ONLY

(iii) Appropriate signs and instructions shall be posted at the entrance to, and exit from, regulated areas, informing employees of the procedures that must be followed in entering and leaving a regulated area.

(2) *Container contents identification.* (i) Containers of 3,3'-Dichlorobenzidine (or its salts) and containers required under paragraphs (c)(4)(v) and (c)(6)(vii)(*b*), and (c)(6)(viii)(*b*) of this section which are accessible only to, and handled only by, authorized employees, or by other employees trained in accordance with subparagraph (5) of this paragraph, may have contents identification limited to a generic or proprietary name, or other proprietary identification, of the carcinogen and percent.

(ii) Containers of 3,3'-Dichlorobenzidine (or its salts) and containers required under paragraphs (c)(4)(v), (c)(6)(vii)(*b*), and (c)(6)(viii)(*b*) of this section which are accessible to, or handled by, employees other than authorized employees or employees trained in accordance with subparagraph (5) of this paragraph shall have contents identification which includes the full chemical name and Chemical Abstracts Service Registry number as listed in paragraph (a)(1) of this section.

(iii) Containers shall have the warning words "CANCER-SUSPECT AGENT" displayed immediately under or adjacent to the contents identification.

(iv) Containers which have 3,3'-Dichlorobenzidine (or its salts) contents with corrosive or irritating properties shall have label statements warning of such hazards, noting, if appropriate, particularly sensitive or affected portions of the body.

(3) *Lettering.* Lettering on signs and instructions required by subparagraph (1) shall be a minimum letter height of 2 inches. Labels on containers required under this section shall not be less than ½ the size of the largest lettering on the package, and not less than 8 point type in any instance; provided that no such required lettering need be more than 1 inch in height.

(4) *Prohibited statements.* No statement shall appear on or near any required sign, label, or instruction which contradicts or detracts from the effect of any required warning, information or instruction.

(5) *Training and indoctrination.* (i) Each employee prior to being authorized to enter a regulated area, shall receive a training and indoctrination program including, but not necessarily limited to:

(*a*) The nature of the carcinogenic hazards of 3,3'-Dichlorobenzidine (or its salts), including local and systemic toxicity;

(*b*) The specific nature of the operation involving 3,3'-Dichlorobenzidine (or its salts) which could result in exposure;

(*c*) The purpose for and application of the medical surveillance program, including, as appropriate, methods of self-examination;

(*d*) The purpose for and application of decontamination practices and purposes;

(*e*) The purpose for and significance of emergency practices and procedures;

(*f*) The employee's specific role in emergency procedures;

(*g*) Specific information to aid the employee in recognition and evaluation of conditions and situations which may result in the release of 3,3'-Dichlorobenzidine (or its salts);

(*h*) *The purpose for and application of specific first aid procedures and practices;*

(*i*) A review of this section at the employee's first training and indoctrination program and annually thereafter.

(ii) Specific emergency procedures shall be prescribed, and posted, and employees shall be familiarized with their terms, and rehearsed in their application.

(iii) All materials relating to the program shall be provided upon request to authorized representatives of the Assistant Secretary and the Director.

(f) *Reports*—(1) *Operations.* Not later than March 1, 1974, the information required in subparagraphs (i), (ii), (iii), and (iv) of this paragraph shall be reported in writing to the nearest OSHA Area Director. Any changes in such information shall be similarly reported in writing within 15 calendar days of such change. (i) A brief description and in-plant location of the area(s) regulated and the address of each regulated area;

(ii) The name(s) and other identifying information as to the presence of 3,3'-Dichlorobenzidine (or its salts) in each regulated area;

(iii) The number of employees in each regulated area, during normal operations including maintenance activities; and

(iv) The manner in which 3,3'-Dichlorobenzidine (or its salts) is present in each regulated area; e.g. whether it is manufactured, processed, used, repackaged, released, stored, or otherwise handled.

(2) *Incidents.* Incidents which result in the release of 3,3'-Dichlorobenzidine (or its salts) into any area where employees may be potentially exposed shall be reported in accordance with this subparagraph. (i) A report of the occurrence of the incident and the facts obtainable at that time including a report on any medical treatment of affected employees shall be made within 24 hours to the nearest OSHA Area Director.

(ii) A written report shall be filed with the nearest OSHA Area Director within 15 calendar days thereafter and shall include:

(*a*) A specification of the amount of material released, the amount of time involved, and an explanation of the procedure used in determining this figure;

(*b*) A description of the area involved, and the extent of known and possible employee exposure and area contamination, and

(*c*) A report of any medical treatment of affected employees, and any medical surveillance program implemented; and

(*d*) An analysis of the circumstances of the incident, and measures taken or to be taken, with specific completion dates, to avoid further similar releases.

(g) *Medical surveillance.* At no cost to the employee, a program of medical surveillance shall be established and implemented for employees considered for assignment to enter regulated areas, and for authorized employees.

(1) *Examinations.* (i) Before an employee is assigned to enter a regulated area, a preassignment physical examination by a physician shall be provided. The examination shall include the personal history of the employee, family and occupational background, including genetic and environmental factors.

(ii) Authorized employees shall be provided periodic physical examinations, not less often than annually, following the preassignment examination.

(iii) In all physical examinations, the examining physician shall consider whether there exist conditions of increased risk, including reduced im-

munological competence, those undergoing treatment with steroids of cytotoxic agents, pregnancy and cigarette smoking.

(2) *Records.* (i) Employers of employees examined pursuant to this paragraph shall cause to be maintained complete and accurate records of all such medical examinations. Records shall be maintained for the duration of the employee's employment. Upon termination of the employee's employment, including retirement or death, or in the event that the employer ceases business without a successor, records, or notarized true copies thereof, shall be forwarded by registered mail to the Director.

(ii) Records required by this paragraph shall be provided upon request to authorized representatives of the Assistant Secretary or the Director; and upon request of an employee or former employee, to a physician designated by the employee or to a new employer.

(iii) Any physician who conducts a medical examination required by this paragraph shall furnish to the employer a statement of the employee's suitability for employment in the specific exposure.

§ 1910.1008 bis-Chloromethyl ether.

(a) *Scope and application.* (1) This section applies to any area in which bis-Chloromethyl ether, Chemical Abstracts Service Registry Number 542881 is manufactured, processed, repackaged, released, handled, or stored, but shall not apply to trans-shipment in sealed containers, except for the labeling requirements under paragraphs (e)(2), (3), and (4) of this section.

(2) This section shall not apply to solid or liquid mixtures containing less than 0.1 percent by weight or volume of bis-Chloromethyl ether.

(b) *Definitions.* For the purposes of this section: (1) "Absolute filter" is one capable of retaining 99.97 percent of a mono disperse aerosol of 0.3 μm particles.

(2) "Authorized employee" means an employee whose duties require him to be in the regulated area and who has been specifically assigned by the employer.

(3) "Clean change room" means a room where employees put on clean clothing and/or protective equipment in an environment free of bis-Chloromethyl ether. The clean change room shall be contiguous to and have an entry from a shower room, when the shower room facilities are otherwise required in this section.

(4) "Closed system" means an operation involving bis-Chloromethyl ether where containment prevents the release of bis-Chloromethyl ether into regulated areas, nonregulated areas, or the external environment.

(5) "Decontamination" means the inactivation of bis-Chloromethyl ether or its safe disposal.

(6) "Director" means the Director, National Institute for Occupational Safety and Health, or any person directed by him or the Secretary of Health, Education, and Welfare to act for the Director.

(7) "Disposal" means the safe removal of bis-Chloromethyl ether from the work environment.

(8) "Emergency" means an unforeseen circumstance or set of circumstances resulting in the release of bis-Chloromethyl ether which may result in exposure to or contact with bis-Chloromethyl ether.

(9) "External environment" means any environment external to regulated and nonregulated areas.

(10) "Isolated system" means a fully enclosed structure other than the vessel of containment, of bis-Chloromethyl ether, which is impervious to the passage of bis-Chloromethyl ether and which would prevent the entry of bis-Chloromethyl ether into regulated areas, nonregulated areas, or the external environment, should leakage or spillage from the vessel of containment occur.

(11) "Laboratory type hood" is a device enclosed on three sides and the top and bottom, designed and maintained so as to draw air inward at an average linear face velocity of 150 feet per minute with a minimum of 125 feet per minute; designed, constructed, and maintained in such a way that an operation involving bis-Chloromethyl ether within the hood does not require the insertion of any portion of any employee's body other than his hands and arms.

(12) "Nonregulated area" means any area under the control of the employer where entry and exit is neither restricted nor controlled.

(13) "Open-vessel system" means an operation involving bis-Chloromethyl ether in an open vessel, which is not in an isolated system, a laboratory type hood, nor in any other system affording equivalent protection against the entry of bis-Chloromethyl ether into regulated areas, nonregulated areas, or the external environment.

(14) "Protective clothing" means clothing designed to protect an employee against contact with or exposure to bis-Chloromethyl ether.

(15) "Regulated area" means an area where entry and exit is restricted and controlled.

(c) *Requirements for areas containing bis-Chloromethyl ether.* A regulated area shall be established by an employer where bis-Chloromethyl ether is manufactured, processed, used, repackaged, released, handled or stored. All such areas shall be controlled in accordance with the requirements for the following category or categories describing the operation involved: (1) *Isolated systems.* Employees working with bis-Chloromethyl ether within an isolated system, such as a "glove box" shall wash their hands and arms upon completion of the assigned task and before engaging in other activities not associated with the isolated system.

(2) *Closed system operation.* Within regulated areas where bis-Chloromethyl ether is stored in sealed containers, or contained in a closed system, including piping systems, with any sample ports or openings closed while bis-Chloromethyl ether is contained within. Access shall be restricted to authorized employees only.

(3) *Open vessel system operations.* Open vessel system operations as defined in paragraph (b)(13) of this section are prohibited.

(4) *Transfer from a closed system, charging or discharging point operations, or otherwise opening a closed system.* In operations involving "laboratory type hoods," or in locations where bis-Chloromethyl ether is contained in an otherwise "closed system," but is transferred, charged, or discharged into other normally closed containers, the provisions of this subparagraph shall apply.

(i) Access shall be restricted to authorized employees only;

(ii) Each operation shall be provided with continuous local exhaust ventilation so that air movement is always from ordinary work areas to the operation. Exhaust air shall not be discharged to regulated areas, nonregulated areas or the external environment unless decontaminated. Clean makeup air shall be introduced in sufficient volume to maintain the correct operation of the local exhaust system.

(iii) Employees shall be provided with, and required to wear, clean, full body protective clothing (smocks, coveralls, or long-sleeved shirt and pants), and gloves prior to entering the regulated area.

(iv) Employees engaged in bis-Chloromethyl ether handling operations shall be provided with and required to wear and use a full-face, supplied air respirator, of the continuous flow or pressure-demand type, in accordance with § 1910.134.

(v) Prior to each exit from a regulated area, employees shall be required to remove and leave protective clothing and equipment at the point of exit and at the last exit of the day, to place used clothing and equipment in impervious containers at the point of exit for purposes of decontamination or disposal. The contents of such impervious containers shall be identified, as required under paragraphs (e)(2), (3), and (4) of this section.

(vi) Drinking fountains are prohibited in the regulated area.

(5) *Maintenance and decontamination activities.* In cleanup of leaks or spills, maintenance or repair operations on contaminated systems or equipment, or any operations involving work in an area where direct contact with bis-Chloromethyl ether could result, each authorized employee entering that area shall:

(i) Be provided with and required to wear clean, impervious garments, including gloves, boots and continuous-air supplied hood in accordance with § 1910.134.

(ii) Be decontaminated before removing the protective garments and hood;

(iii) Be required to shower upon removing the protective garments and hood.

(6) *Laboratory activities.* [Deleted]

(d) *General regulated area requirements*—(1) *Employee identification.* A daily roster of employees entering regulated areas shall be established and maintained. The rosters or a summary of the rosters, shall be retained for a period of 20 years. The rosters and/or summaries shall be provided upon request to authorized representatives of the Assistant Secretary and the Director. In the event that the employer ceases business without a successor, rosters shall be forwarded by registered mail to the Director.

(2) *Emergencies.* In an emergency, immediate measures including, but not limited to, the requirements of subdivisions (i), (ii), (iii), (iv), and (v) of this paragraph shall be implemented.

(i) The potentially affected area shall be evacuated as soon as the emergency has been determined.

(ii) Hazardous conditions created by the emergency shall be eliminated and the potentially affected area shall be decontaminated prior to the resumption of normal operations.

(iii) Special medical surveillance by a physician shall be instituted within 24 hours for employees present in the potentially affected area at the time of the emergency. A report of the medical surveillance and any treatment shall be included in the incident report, in accordance with paragraph (f)(2) of this section.

(iv) Where an employee has a known contact with bis-Chloromethyl ether such employee shall be required to shower as soon as possible, unless contraindicated by physical injuries.

(v) An incident report on the emergency shall be reported as provided in paragraph (f)(2) of this section.

(3) *Hygiene facilities and practices.* (i) Storage or consumption of food, storage or use of containers of beverages, storage or application of cosmetics, smoking, storage of smoking materials, tobacco products or other products for chewing, or the chewing of such products, are prohibited in regulated areas.

(ii) Where employees wear protective clothing and equipment clean change rooms shall be provided, in accordance with § 1910.141(e), for the number of such employees required to change clothes.

(iii) Where toilets are in regulated areas, such toilets shall be in a separate room.

(iv) Where employees are required by this section to wash, washing facilities shall be provided in accordance with § 1910.141(d) (1) and (2) (ii) through (vii).

(v) Where employees are required by this section to shower, shower facilities shall be provided in accordance with § 1910.141(d)(3).

(4) *Contamination control.* (i) Regulated areas, except for outdoor systems, shall be maintained under pressure negative with respect to nonregulated areas. Local exhaust ventilation may be used to satisfy this requirement. Clean makeup air in equal volume shall replace air removed.

(ii) Any equipment, material, or other item taken into or removed from a regulated area shall be done so in a manner that does not cause contamination in nonregulated areas or the external environment.

(iii) Decontamination procedures shall be established and implemented to remove bis-Chloromethyl ether from the surfaces of materials, equipment and the decontamination facility.

(e) *Signs, information and training*—(1) *Signs.* (i) Entrances to regulated areas shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT

AUTHORIZED PERSONNEL ONLY

(ii) Entrances to regulated areas containing operations covered in paragraph (c)(5) of this section shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT
EXPOSED IN THIS AREA

IMPERVIOUS SUIT INCLUDING GLOVES, BOOTS, AND AIR-SUPPLIED HOOD REQUIRED AT ALL TIMES

AUTHORIZED PERSONNEL ONLY

(iii) Appropriate signs and instructions shall be posted at the entrance to, and exit from, regulated areas, informing employees of the procedures that must be followed in entering and leaving a regulated area.

(2) *Container contents identifications.* (i) Containers of bis-Chloromethyl ether and containers required under paragraphs (c)(4)(v) and (c)(6)(vii)(*b*), and (c)(6)(viii)(*b*) of this section which are accessible only to, and handled only by, authorized employees, or by other employees trained in accordance with subparagraph (5) of this paragraph, may have contents identification limited to a generic or proprietary name, or other proprietary identification, of the carcinogen and percent.

(ii) Containers of bis-Chloromethyl ether and containers required under paragraphs (c)(4)(v), (c)(6)(vii)(*b*), and (c)(6)(viii)(*b*) of this section which are accessible to, or handled by employees other than authorized employees or employees trained in accordance with subparagraph (5) of this paragraph shall have contents identification which includes the full chemical name and Chemical Abstracts Service Registry number as listed in paragraph (a)(1) of this section.

(iii) Containers shall have the warning words "CANCER-SUSPECT AGENT" displayed immediately under or adjacent to the contents identification.

(iv) Containers which have bis-Chloromethyl ether contents with corrosive or irritating properties shall have label statements warning of such hazards, noting, if appropriate, particularly sensitive or affected portions of the body.

(3) *Lettering.* Lettering on signs and instructions required by subparagraph (1) shall be a minimum letter height of 2 inches. Labels on containers required under this section shall not be less than ½ the size of the largest lettering on the package, and not less than 8 point type in any instance; provided, that no such required lettering need be more than 1 inch in height.

(4) *Prohibited statements.* No statement shall appear on or near any required sign, label, or instruction which contradicts or detracts from the effect of any required warning, information or instruction.

(5) *Training and indoctrination.* (i) Each employee prior to being authorized to enter a regulated area, shall receive a training and indoctrination program including, but not necessarily limited to:

(*a*) The nature of the carcinogenic hazards of bis-Chloromethyl ether, including local and systemic toxicity;

(*b*) The specific nature of the operation involving bis-Chloromethyl ether which could result in exposure;

(*c*) The purpose for and application of the medical surveillance program, including, as appropriate, methods of self-examination;

(*d*) The purpose for and application of decontamination practices and purposes;

(*e*) The purpose for and significance of emergency practices and procedures;

(*f*) The employee's specific role in emergency procedures;

(g) Specific information to aid the employee in recognition and evaluation of conditions and situations which may result in the release of bis-Chloromethyl ether;

(h) The purpose for and application of specific first aid procedures and practices;

(i) A review of this section at the employee's first training and indoctrination program and annually thereafter.

(ii) Specific emergency procedures shall be prescribed, and posted, and employees shall be familiarized with their terms, and rehearsed in their application.

(iii) All materials relating to the program shall be provided upon request to authorized representatives of the Assistant Secretary and the Director.

(f) *Reports*—(1) *Operations.* Not later than March 1, 1974, the information required in subparagraphs (i), (ii), (iii), and (iv) of this paragraph shall be reported in writing to the nearest OSHA Area Director. Any changes in such information shall be similarly reported in writing within 15 calendar days of such change. (i) A brief description and in-plant location of the area(s) regulated and the address of each regulated area;

(ii) The name(s) and other identifying information as to the presence of bis-Chloromethyl ether in each regulated area;

(iii) The number of employees in each regulated area, during normal operations including maintenance activities; and

(iv) The manner in which bis-Chloromethyl ether is present in each regulated area; e.g. whether it is manufactured, processed, used, repackaged, released, stored, or otherwise handled.

(2) *Incidents.* Incidents which result in the release of bis-Chloromethyl ether into any area where employees may be potentially exposed shall be reported in accordance with this subparagraph.

(i) A report of the occurrence of the incident and the facts obtainable at that time including a report on any medical treatment of affected employees shall be made within 24 hours to the nearest OSHA Area Director.

(ii) A written report shall be filed with the nearest OSHA Area Director within 15 calendar days thereafter and shall include:

(a) A specification of the amount of material released, the amount of time involved, and an explanation of the procedure used in determining this figure;

(b) A description of the area involved, and the extent of known and possible employee exposure and area contamination; and

(c) A report of any medical treatment of affected employees, and any medical surveillance program implemented; and

(d) An analysis of the circumstances of the incident, and measures taken or to be taken, with specific completion dates, to avoid further similar releases.

(g) *Medical surveillance.* At no cost to the employee, a program of medical surveillance shall be established and implemented for employees considered for assignment to enter regulated areas, and for authorized employees.

(1) *Examinations.* (i) Before an employee is assigned to enter a regulated area, a preassignment physical examination by a physician shall be provided. The examination shall include the personal history of the employee, family and occupational background, including genetic and environmental factors.

(ii) Authorized employees shall be provided periodic physical examinations, not less often than annually, following the preassignment examination.

(iii) In all physical examinations, the examining physician shall consider whether there exist conditions of increased risk, including reduced immunological competence, those undergoing treatment with steroids or cytotoxic agents, pregnancy and cigarette smoking.

(2) *Records.* (i) Employers of employees examined pursuant to this paragraph shall cause to be maintained complete and accurate records of all such medical examinations. Records shall be maintained for the duration of the employee's employment. Upon termination of the employee's employment, including retirement or death, or in the event that the employer ceases business without a successor, records, or notarized true copies thereof, shall be forwarded by registered mail to the Director.

(ii) Records required by this paragraph shall be provided upon request to authorized representatives of the Assistant Secretary or the Director; and upon request of an employee or to a new employer.

(iii) Any physician who conducts a medical examination required by this paragraph shall furnish to the employer a statement of the employee's suitability for employment in the specific exposure.

### § 1910.1009 beta-Naphthylamine.

(a) *Scope and application.* (1) This section applies to any area in which beta-Naphthylamine, Chemical Abstracts Service Registry Number 91598 is manufactured, processed, repackaged, released, handled, or stored, but shall not apply to transshipment in sealed containers, except for the labeling requirements under paragraphs (e) (2), (3), and (4) of this section.

(2) This section shall not apply to solid or liquid mixtures containing less than 0.1 percent by weight or volume of beta-Naphthylamine.

(3) This section will not apply to operations involving the destructive distillation of carbonaceous materials, such as occurs in coke ovens.

(b) *Definitions.* For the purposes of this section:

(1) "Absolute filter" is one capable of retaining 99.97 percent of a mono disperse aerosol of 0.3 μm particles.

(2) "Authorized employee" means an employee whose duties require him to be in the regulated area and who has been specifically assigned by the employer.

(3) "Clean change room" means a room where employees put on clean clothing and/or protective equipment in an environment free of beta-Naphthylamine. The clean change room shall be contiguous to and have an entry from a shower room, when the shower room facilities are otherwise required in this section.

(4) "Closed system" means an operation involving beta-Naphthylamine where containment prevents the release of beta-Naphthylamine into regulated areas, nonregulated areas, or the external environment.

(5) "Decontamination" means the inactivation of beta-Naphthylamine or its safe disposal.

(6) "Director" means the Director, National Institute for Occupational Safety and Health, or any person directed by him or the Secretary of Health, Education, and Welfare to act for the Director.

(7) "Disposal" means the safe removal of beta-Naphthylamine from the work environment.

(8) "Emergency" means an unforeseen circumstance or set of circumstances resulting in the release of beta-Naphthylamine which may result in exposure to or contact with beta-Naphthylamine.

(9) "External environment" means any environment external to regulated and nonregulated areas.

(10) "Isolated system" means a fully enclosed structure other than the vessel of containment of beta-Naphthylamine, which is impervious to the passage of beta-Naphthylamine, and which would prevent the entry of beta-Naphthylamine into regulated areas, nonregulated areas, or the external environment, should leakage or spillage from the vessel of containment occur.

(11) "Laboratory type hood" is a device enclosed on three sides and the top and bottom, designed and maintained so as to draw air inward at an average linear face velocity of 150 feet per minute with a minimum of 125 feet per minute; designed, constructed, and maintained in such a way that an

operation involving beta-Naphthylamine within the hood does not require the insertion of any portion of any employee's body other than his hands and arms.

(12) "Nonregulated area" means any area under the control of the employer where entry and exit is neither restricted nor controlled.

(13) "Open-vessel system" means an operation involving beta-Naphthylamine in an open vessel, which is not in an isolated system, a laboratory type hood, nor in any other system affording equivalent protection against the entry of beta-Naphthylamine into regulated areas, nonregulated areas, or the external environment.

(14) "Protective clothing" means clothing designed to protect an employee against contact with or exposure to beta-Naphthylamine.

(15) "Regulated area" means an area where entry and exit is restricted and controlled.

(c) *Requirements for areas containing beta-Naphthylamine.* A regulated area shall be established by an employer where beta-Naphthylamine is manufactured, processed, used, repackaged, released, handled or stored. All such areas shall be controlled in accordance with the requirements for the following category or categories describing the operation involved: (1) *Isolated systems.* Employees working with beta-Naphthylamine within an isolated system, such as a "glove box" shall wash their hands and arms upon completion of the assigned task and before engaging in other activities not associated with the isolated system.

(2) *Closed system operation.* Within regulated areas where beta-Naphthylamine is stored in sealed containers, or contained in a closed system, including piping systems, with any sample ports or openings closed while beta-Napthylamine is contained within:

(i) Access shall be restricted to authorized employees only;

(ii) Employees shall be required to wash hands, forearms, face and neck upon each exit from the regulated areas, close to the point of exit and before engaging in other activities.

(3) *Open vessel system operations.* Open vessel system operations as defined in paragraph (b)(13) of this section are prohibited.

(4) *Transfer from a closed system, charging or discharging point operations, or otherwise opening a closed system.* In operations involving "laboratory type hoods," or in locations where beta-Naphthylamine is contained in an otherwise "closed system," but is transferred, charged, or discharged into other normally closed containers, the provisions of this paragraph shall apply.

(i) Access shall be restricted to authorized employees only.

(ii) Each operation shall be provided with continuous local exhaust ventilation so that air movement is always from ordinary work areas to the operation. Exhaust air shall not be discharged to regulated areas, nonregulated areas or the external environment unless decontaminated. Clean makeup air shall be introduced in sufficient volume to maintain the correct operation of the local exhaust system.

(iii) Employees shall be provided with, and required to wear, clean, full body protective clothing (smocks, coveralls, or long-sleeved shirt and pants), shoe covers and gloves prior to entering the regulated area.

(iv) Employees engaged in beta-Naphthylamine handling operations shall be provided with and required to wear and use a half-face, filter-type respirator for dusts, mists, and fumes, in accordance with § 1910.134. A respirator affording higher levels of protection may be substituted.

(v) Prior to each exit from a regulated area, employees shall be required to remove and leave protective clothing and equipment at the point of exit and at the last exit of the day, to place used clothing and equipment in impervious containers at the point of exit for purposes of decontamination or disposal. The contents of such impervious containers shall be identified, as required under paragraphs (e) (2), (3), and (4) of this section.

(vi) Employees shall be required to wash hands, forearms, face and neck on each exit from the regulated area, close to the point of exit, and before engaging in other activities.

(vii) Employees shall be required to shower after the last exit of the day.

(viii) Drinking fountains are prohibited in the regulated area.

(5) *Maintenance and decontamination activities.* In cleanup of leaks or spills, maintenance or repair operations on contaminated systems or equipment, or any operations involving work in an area where direct contact with beta-Naphthylamine could result, each authorized employee entering that area shall:

(i) Be provided with and required to wear clean, impervious garments, including gloves, boots and continuous-air suppled hood in accordance with § 1910.134.

(ii) Be decontaminated before removing the protective garments and hood;

(iii) Be required to shower upon removing the protective garments and hood.

(6) *Laboratory activities.* [Deleted]

(d) *General regulated area requirements*—(1) *Employee identification.* A daily roster of employees entering regulated areas shall be established and maintained. The rosters or a summary of the rosters, shall be retained for a period of 20 years. The rosters and/or summaries shall be provided upon request to authorized representatives of the Assistant Secretary and the Director. In the event that the employer ceases business without a successor, rosters shall be forwarded by registered mail to the Director.

(2) *Emergencies.* In an emergency, immediate measures including, but not limited to, the requirements of subdivisions (i), (ii), (iii), (iv), and (v) of this section shall be implemented.

(i) The potentially affected area shall be evacuated as soon as the emergency has been determined.

(ii) Hazardous conditions created by the emergency shall be eliminated and the potentially affected area shall be decontaminated prior to the resumption of normal operations.

(iii) Special medical surveillance by a physician shall be instituted within 24 hours for employees present in the potentially affected area at the time of the emergency. A report of the medical surveillance and any treatment shall be included in the incident report, in accordance with paragraph (f)(2) of this section.

(iv) Where an employee has a known contact with beta-Napthylamine, such employee shall be required to shower as soon as possible, unless contraindicated by physical injuries.

(v) An incident report on the emergency shall be reported as provided in paragraph (f)(2) of this section.

(3) *Hygiene facilities and practices.* (i) Storage or consumption of food, storage or use of containers of beverages, storage or application of cosmetics, smoking, storage of smoking materials, tobacco products or other products for chewing, or the chewing of such products, are prohibited in regulated areas.

(ii) Where employees are required by this section to wash, washing facilities shall be provided in accordance with § 1910.141(d) (1) and (2) (ii) through (vii).

(iii) Where employees are required by this section to shower, shower facilities shall be provided in accordance with § 1910.141(d)(3).

(iv) Where employees wear protective clothing and equipment, clean change rooms shall be provided, in accordance with § 1910.141(e), for the number of such employees required to change clothes.

(v) Where toilets are in regulated areas, such toilets shall be in a separate room.

(4) *Contamination control.* (i) Regulated areas, except for outdoor systems, shall be maintained under pressure negative with respect to nonregulated areas. Local exhaust ventilation may be used to satisfy this require-

ment. Clean makeup air in equal volume shall replace air removed.

(ii) Any equipment, material, or other item taken into or removed from a regulated area shall be done so in a manner that does not cause contamination in nonregulated areas or the external environment.

(iii) Decontamination procedures shall be established and implemented to remove beta-Naphthylamine from the surfaces of materials, equipment and the decontamination facility.

(iv) Dry sweeping and dry mopping are prohibited.

(e) *Signs, information and training*—(1) *Signs.* (i) Entrances to regulated areas shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT

AUTHORIZED PERSONNEL ONLY

(ii) Entrances to regulated areas containing operations covered in paragraph (c)(5) of this section shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT
EXPOSED IN THIS AREA

IMPERVIOUS SUITS INCLUDING GLOVES, BOOTS, AND AIR-SUPPLIED HOOD REQUIRED AT ALL TIMES

AUTHORIZED PERSONNEL ONLY

(iii) Appropriate signs and instructions shall be posted at the entrance to, and exit from, regulated areas, informing employees of the procedures that must be followed in entering and leaving a regulated area.

(2) *Container contents identification.* (i) Containers of beta-Naphthylamine and containers required under paragraphs (c)(4)(v) and (c)(6)(vii)(*b*), and (c)(6)(viii)(*b*) of this section which are accessible only to, and handled only by, authorized employees, or by other employees trained in accordance with subparagraph (5) of this paragraph may have contents identification limited to a generic or proprietary name, or other proprietary identification, of the carcinogen and percent.

(ii) Containers of beta-Naphthylamine and containers required under paragraphs (c)(4)(v), (c)(6)(vii)(*b*), and (c)(6)(viii)(*b*) of this section which are accessible to, or handled by employees other than authorized employees or employees trained in accordance with paragraph (5) of this paragraph shall have contents identification which includes the full chemical name and Chemical Abstracts Service Registry number as listed in paragraph (a)(1) of this section.

(iii) Containers shall have the warning words "CANCER-SUSPECT AGENT" displayed immediately under or adjacent to the contents identification.

(iv) Containers which have beta-Naphthylamine contents with corrosive or irritating properties shall have label statements warning of such hazards, noting, if appropriate, particularly sensitive or affected portions of the body.

(3) *Lettering.* Lettering on signs and instructions required by subparagraph (1) shall be a minimum letter height of 2 inches. Labels on containers required under this section shall not be less than ½ the size of the largest lettering on the package, and not less than 8 point type in any instance: *Provided,* That no such required lettering need be more than 1 inch in height.

(4) *Prohibited statements.* No statement shall appear on or near any required sign, label, or instruction which contradicts or detracts from the effect of any required warning, information or instruction.

(5) *Training and indoctrination.* (i) Each employee prior to being authorized to enter a regulated area, shall receive a training and indoctrination program including, but not necessarily limited to:

(*a*) The nature of the carcinogenic hazards of beta-Naphthylamine, including local and systemic toxicity;

(*b*) The specific nature of the operation involving beta-Naphthylamine which could result in exposure;

(*c*) The purpose for and application of the medical surveillance program, including, as appropriate, methods of self-examination;

(*d*) The purpose for and application of decontamination practices and purposes;

(*e*) The purpose for and significance of emergency practices and procedures;

(*f*) The employee's specific role in emergency procedures;

(*g*) Specific information to aid the employee in recognition and evaluation of conditions and situations which may result in the release of beta-Naphthylamine;

(*h*) The purpose for and application of specific first aid procedures and practices;

(*i*) A review of this section at the employee's first training and indoctrination program and annually thereafter.

(ii) Specific emergency procedures shall be prescribed, and posted, and employees shall be familiarized with their terms, and rehearsed in their application.

(iii) All materials relating to the program shall be provided upon request to authorized representatives of the Assistant Secretary and the Director.

(f) *Reports*—(1) *Operations.* Not later than March 1, 1974, the information required in subparagraphs (i), (ii), (iii), and (iv) of this paragraph shall be reported in writing to the nearest OSHA Area Director. Any changes in such information shall be similarly reported in writing within 15 calendar days of such change. (i) A brief description and in-plant location of the area(s) regulated and the address of each regulated area;

(ii) The name(s) and other identifying information as to the presence of beta-Naphthylamine in each regulated area;

(iii) The number of employees in each regulated area, during normal operations including maintenance activities; and

(iv) The manner in which beta-Naphthylamine is present in each regulated area; e.g. whether it is manufactured, processed, used, repackaged, released, stored, or otherwise handled.

(2) *Incidents.* Incidents which result in the release of beta-Naphthylamine into any area where employees may be potentially exposed shall be reported in accordance with this subparagraph.

(i) A report of the occurrence of the incident and the facts obtainable at that time including a report on any medical treatment of affected employees shall be made within 24 hours to the nearest OSHA Area Director.

(ii) A written report shall be filed with the nearest OSHA Area Director within 15 calendar days thereafter and shall include:

(*a*) A specification of the amount of material released, the amount of time involved, and an explanation of the procedure used in determining this figure;

(*b*) A description of the area involved, and the extent of known and possible employee exposure and area contamination;

(*c*) A report of any medical treatment of affected employees, and any medical surveillance program implemented; and

(*d*) An analysis of the circumstances of the incident, and measures taken or to be taken, with specific completion dates, to avoid further similar releases.

(g) *Medical surveillance.* At no cost to the employee, a program of medical surveillance shall be established and implemented for employees considered for assignment to enter regulated areas, and for authorized employees.

(1) *Examinations.* (i) Before an employee is assigned to enter a regulated area, a preassignment physical examination by a physician shall be provided. The examination shall include the personal history of the employee, family and occupational background, including genetic and environmental factors.

(ii) Authorized employees shall be provided periodic physical examinations, not less often than annually, following the preassignment examination.

(iii) In all physical examinations the examining physician shall consider whether there exist conditions of increased risk, including reduced immunological competence, those undergoing treatment with steroids or cytotoxic agents, pregnancy and cigarette smoking.

(2) *Records.* (i) Employers of employees examined pursuant to this paragraph shall cause to be maintained complete and accurate records of all such medical examinations. Records shall be maintained for the duration of the employee's employment. Upon termination of the employee's employment, including retirement or death, or in the event that the employer ceases business without a successor, records, or notarized true copies thereof, shall be forwarded by registered mail to the Director.

(ii) Records required by this paragraph shall be provided upon request to authorized representatives of the Assistant Secretary or the Director; and upon request of an employee or former employee, to a physician designated by the employee or to a new employer.

(iii) Any physician who conducts a medical examination required by this paragraph shall furnish to the employer a statement of the employee's suitability for employment in the specific exposure.

§ 1910.1010 Benzidine.

(a) *Scope and application.* (1) This section applies to any area in which Benzidine, Chemical Abstracts Service Registry Number 92875 is manufactured, processed, repackaged, released, handled, or stored, but shall not apply to transshipment in sealed containers, except for the labeling requirements under paragraphs (e)(2), (3), and (4) of this section.

(2) This section shall not apply to solid or liquid mixutures containing less than 0.1 percent by weight or volume of Benzidine.

(b) *Definitions.* For the purposes of this section: (1) "Absolute filter" is one capable of retaining 99.97 percent of a mono dispense aerosol of 0.3 μm particles.

(2) "Authorized employee" means an employee whose duties require him to be in the regulated area and who has been specifically assigned by the employer.

(3) "Clean change room" means a room where employees put on clean clothing and/or protective equipment in an environment free of Benzidine. The clean change room shall be contiguous to and have an entry from a shower room, when the shower room facilities are otherwise required in this section.

(4) "Closed system" means an operation involving Benzidine where containment prevents the release of Benzidine into regulated areas, nonregulated areas, or the external environment.

(5) "Decontamination" means the inactivation of Benzidine or its safe disposal.

(6) "Director" means the Director, National Institute for Occupational Safety and Health, or any person directed by him or the Secretary of Health, Education, and Welfare to act for the Director.

(7) "Disposal" means the safe removal of Benzidine from the work environment.

(8) "Emergency" means an unforeseen circumstance or set of circumstances resulting in the release of Benzidine which may result in exposure to or contact with Benzidine.

(9) "External environment" means any environment external to regulated and nonregulated areas.

(10) "Isolated system" means a fully enclosed structure other than the vessel of containment of Benzidine, which is impervious to the passage of Benzidine, and which would prevent the entry of Benzidine into regulated areas, nonregulated areas, or the external environment, should leakage or spillage from the vessel of containment occur.

(11) "Laboratory type hood" is a device enclosed on three sides and the top and bottom, designed and maintained so as to draw air inward at an average linear face velocity of 150 feet per minute with a minimum of 125 feet per minute; designed, constructed, and maintained in such a way that an operation involving Benzidine within the hood does not require the insertion of any portion of any employee's body other than his hands and arms.

(12) "Nonregulated area" means any area under the control of the employer where entry and exit is neither restricted nor controlled.

(13) "Open-vessel system" means an operation involving Benzidine in an open vessel, which is not in an isolated system, a laboratory type hood, nor in any other system affording equivalent protection against the entry of Benzidine into regulated areas, nonregulated areas, or the external environment.

(14) "Protective clothing" means clothing designed to protect an employee against contact with or exposure to Benzidine.

(15) "Regulated area" means an area where entry and exit is restricted and controlled.

(c) *Requirements for areas containing Benzidine.* A regulated area shall be established by an employer where Benzidine is manufactured, processed, used, repackaged, released, handled or stored. All such areas shall be controlled in accordance with the requirements for the following category or categories describing the operation involved: (1) *Isolated systems.* Employees working with Benzidine within an isolated system, such as a "glove box" shall wash their hands and arms upon completion of the assigned task and before engaging in other activities not associated with the isolated system.

(2) *Closed system operation.* Within regulated areas where Benzidine is stored in sealed containers, or contained in a closed system, including piping systems, with any sample ports or openings closed while Benzidine is contained within: (i) Access shall be restricted to authorized employees only;

(ii) Employees shall be required to wash hands, forearms, face and neck upon each exit from the regulated areas, close to the point of exit and before engaging in other activities.

(3) *Open vessel system operations.* Open vessel system operations as defined in paragraph (b)(13) of this section are prohibited.

(4) *Transfer from a closed system, charging or discharging point operations, or otherwise opening a closed system.* In operations involving "laboratory type hoods," or in locations where Benzidine is contained in an otherwise "closed system," but is transferred, charged, or discharged into other normally closed containers, the provisions of this subparagraph shall apply.

(i) Access shall be restricted to authorized employees only;

(ii) Each operation shall be provided with continuous local exhaust ventilation so that air movement is always from ordinary work areas to the operation. Exhaust air shall not be discharged to regulated areas, nonregulated areas or the external environment unless decontaminated. Clean makeup air shall be introduced in sufficient volume to maintain the correct operation of the local exhaust system.

(iii) Employees shall be provided with, and required to wear, clean, full body protective clothing (smocks, coveralls, or long-sleeved shirt and pants), shoe covers and gloves prior to entering the regulated area.

(iv) Employees engaged in Benzidine handling operations shall be provided with and required to wear and use a half-face, filter-type respirator for dusts, mists, and fumes, in accordance with § 1910.134. A respirator affording higher levels of protection may be substituted.

(v) Prior to each exit from a regulated area, employees shall be required to remove and leave protective clothing and equipment at the point of exit and at the last exit of the day, to place used clothing and equipment in impervious containers at the point of exit for purposes of decontamination or disposal. The contents of such imper-

vious containers shall be identified, as required under paragraphs (e)(2), (3), and (4) of this section.

(vi) Employees shall be required to wash hands, forearms, face and neck on each exit from the regulated area, close to the point of exit, and before engaging in other activities.

(vii) Employees shall be required to shower after the last exit of the day.

(viii) Drinking fountains are prohibited in the regulated area.

(5) *Maintenance and decontamination activities.* In cleanup of leaks or spills, maintenance or repair operations on contaminated systems or equipment, where direct contact with Benzidine could result, each authorized employee entering that area shall:

(i) Be provided with and required to wear clean, impervious garments, including gloves, boots and continuous-air supplied hood in accordance with § 1910.134.

(ii) Be decontaminated before removing the protective garments and hood;

(iii) Be required to shower upon removing the protective garments and hood.

(6) *Laboratory activities.* [Deleted]

(d) *General regulated area requirements*—(1) *Employee identification.* A daily roster of employees entering regulated areas shall be established and maintained. The rosters or a summary of the rosters, shall be retained for a period of 20 years. The rosters and/or summaries shall be provided upon request to authorized representatives of the Assistant Secretary and the Director. In the event that the employer ceases business without a successor, rosters shall be forwarded by registered mail to the Director.

(2) *Emergencies.* In an emergency, immediate measures including, but not limited to, the requirements of subdivisions (i), (ii), (iii), (iv), and (v) of this paragraph shall be implemented.

(i) The potentially affected area shall be evacuated as soon as the emergency has been determined.

(ii) Hazardous conditions created by the emergency shall be eliminated and the potentially affected area shall be decontaminated prior to the resumption of normal operations.

(iii) Special medical surveillance by a physician shall be instituted within 24 hours for employees present in the potentially affected area at the time of the emergency. A report of the medical surveillance and any treatment shall be included in the incident report, in accordance with paragraph (f)(2) of this section.

(iv) Where an employee has a known contact with Benzidine such employee shall be required to shower as soon as possible unless contraindicated by physical injuries.

(v) An incident report on the emergency shall be reported as provided in paragraph (f)(2) of this section.

(3) *Hygiene facilities and practices.* (i) Storage or consumption of food, storage or use of containers of beverages, storage or application of cosmetics, smoking, storage of smoking materials, tobacco products or other products for chewing, or the chewing of such products, are prohibited in regulated areas.

(ii) Where employees are required by this section to wash, washing facilities shall be provided in accordance with § 1910.141(d)(1) and (2)(ii) through (vii).

(iii) Where employees are required by this section to shower, shower facilities shall be provided in accordance with § 1910.141(d)(3).

(iv) Where employees wear protective clothing and equipment clean change rooms shall be provided, in accordance with § 1910.141(e), for the number of such employees required to change clothes.

(v) Where toilets are in regulated areas, such toilets shall be in a separate room.

(4) *Contamination control.* (i) Regulated areas, except for outdoor systems, shall be maintained under pressure negative with respect to nonregulated areas. Local exhaust ventilation may be used to satisfy this requirement. Clean makeup air in equal volume shall replace air removed.

(ii) Any equipment, material, or other item taken into or removed from a regulated area shall be done so in a manner that does not cause contamination in nonregulated areas or the external environment.

(iii) Decontamination procedures shall be established and implemented to remove Benzidine from the surfaces of materials, equipment and the decontamination facility.

(iv) Dry sweeping and dry mopping are prohibited.

(e) *Signs, information and training*—(1) *Signs.* (i) Entrances to regulated areas shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT

AUTHORIZED PERSONNEL ONLY

(ii) Entrances to regulated areas containing operations covered in paragraph (c)(5) of this section shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT EXPOSED IN THIS AREA

IMPERVIOUS SUIT INCLUDING GLOVES, BOOTS, AND AIR-SUPPLIED HOOD REQUIRED AT ALL TIMES

AUTHORIZED PERSONNEL ONLY

(iii) Appropriate signs and instructions shall be posted at the entrance to, and exit from, regulated areas, informing employees of the procedures that must be followed in entering and leaving a regulated area.

(2) *Container contents identification.* (i) Containers of Benzidine and containers required under paragraphs (c)(4)(v) and (c)(6)(vii)(*b*), and (c)(6)(viii)(*b*) of this section which are accessible only to, and handled only by, authorized employees, or by other employees trained in accordance with subparagraph (5) of this paragraph may have contents identification limited to a generic or proprietary name, or other proprietary identification, of the carcinogen and percent.

(ii) Containers of Benzidine and containers required under paragraphs (c)(4)(v), (c)(6)(vii)(*b*), and (c)(6)(viii)(*b*) of this section which are accessible to, or handled by, employees other than authorized employees or employees trained in accordance with subparagraph (5) of this paragraph shall have contents identification which includes the full chemical name and Chemical Abstracts Service Registry Number as listed in paragraph (a)(1) of this section.

(iii) Containers shall have the warning words "CANCER-SUSPECT AGENT" displayed immediately under or adjacent to the contents identification.

(iv) Containers which have Benzidine contents with corrosive or irritating properties shall have label statements warning of such hazards, noting, if appropriate, particularly sensitive or affected portions of the body.

(3) *Lettering.* Lettering on signs and instructions required by subparagraph (1) shall be a minimum letter height of 2 inches. Labels on containers required under this section shall not be less than ½ the size of the largest lettering on the package, and not less than 8 point type in any instance; *Provided,* That no such required lettering need be more than 1 inch in height.

(4) *Prohibited statements.* No statement shall appear on or near any required sign, label, or instruction which contradicts or detracts from the effect of any required warning, information or instruction.

(5) *Training and indoctrination.* (i) Each employee prior to being authorized to enter a regulated area, shall receive a training and indoctrination

program including, but not necessarily limited to:

(*a*) The nature of the carcinogenic hazards of Benzidine, including local and systemic toxicity;

(*b*) The specific nature of the operation involving Benzidine which could result in exposure;

(*c*) The purpose for and application of the medical surveillance program, including, as appropriate, methods of self-examination;

(*d*) The purpose for and application of decontamination practices and purposes;

(*e*) The purpose for and significance of emergency practices and procedures;

(*f*) The employee's specific role in emergency procedures;

(*g*) Specific information to aid the employee in recognition and evaluation of conditions and situations which may result in the release of Benzidine;

(*h*) The purpose for and application of specific first aid procedures and practices;

(*i*) A review of this section at the employee's first training and indoctrination program and annually thereafter.

(ii) Specific emergency procedures shall be prescribed, and posted, and employees shall be familiarized with their terms, and rehearsed in their application.

(iii) All materials relating to the program shall be provided upon request to authorized representatives of the Assistant Secretary and the Director.

(f) *Reports.* (1) *Operations.* Not later than March 1, 1974, the information required in subparagraphs (i), (ii), (iii), and (iv) of this section shall be reported in writing to the nearest OSHA Area Director. Any changes in such information shall be similarly reported in writing within 15 calendar days of such change.

(i) A brief description and in-plant location of the area(s) regulated and the address of each regulated area;

(ii) The name(s) and other identifying information as to the presence of Benzidine in each regulated area;

(iii) The number of employees in each regulated area, during normal operations including maintenance activities; and

(iv) The manner in which Benzidine is present in each regulated area; e.g. whether it is manufactured, processed, used, repackaged, released, stored, or otherwise handled.

(2) *Incidents.* Incidents which result in the release of Benzidine into any area where employees may be potentially exposed shall be reported in accordance with this paragraph.

(i) A report of the occurrence of the incident and the facts obtainable at that time including a report on any medical treatment of affected employees shall be made within 24 hours to the nearest OSHA Area Director.

(ii) A written report shall be filed with the nearest OSHA Area Director within 15 calendar days thereafter and shall include:

(*a*) A specification of the amount of material released, the amount of time involved, and an explanation of the procedure used in determining this figure;

(*b*) A description of the area involved, and the extent of known and possible employee exposure and area contamination; and

(*c*) A report of any medical treatment of affected employees, and any medical surveillance program implemented; and

(*d*) An analysis of the circumstances of the incident, and measures taken or to be taken, with specific completion dates, to avoid further similar releases.

(g) *Medical surveillance.* At no cost to the employee, a program of medical surveillance shall be established and implemented for employees considered for assignment to enter regulated areas, and for authorized employees.

(1) *Examinations.* (i) Before an employee is assigned to enter a regulated area, a preassignment physical examination by a physician shall be provided. The examination shall include the personal history of the employee, family and occupational background, including genetic and environmental factors.

(ii) Authorized employees shall be provided periodic physical examinations, not less often than annually, following the preassignment examination.

(iii) In all physical examinations, the examining physician shall consider whether there exist conditions of increased risk, including reduced immunological competence, those undergoing treatment with steroids or cytotoxic agents, pregnancy and cigarette smoking.

(2) *Records.* (i) Employers of employees examined pursuant to this paragraph shall cause to be maintained complete and accurate records of all such medical examinations. Records shall be maintained for the duration of the employee's employment. Upon termination of the employee's employment, including retirement or death, or in the event that the employer ceases business without a successor, records, or notarized true copies thereof, shall be forwarded by registered mail to the Director.

(ii) Records required by this paragraph shall be provided upon request to authorized representatives of the Assistant Secretary or the Director; and upon request of an employee or former employee, to a physician designated by the employee or to a new employer.

(iii) Any physician who conducts a medical examination required by this paragraph shall furnish to the employer a statement of the employee's suitability for employment in the specific exposure.

**§ 1910.1011 4-Aminodiphenyl.**

(a) *Scope and application.* (1) This section applies to any area in which 4-Aminodiphenyl, Chemical Abstracts Service Registry Number 92671 is manufactured, processed, repackaged, released, handled, or stored, but shall not apply to trans-shipment in sealed containers, except for the labeling requirements under paragraphs (e) (2), (3), and (4) of this section.

(2) This section shall not apply to solid or liquid mixtures containing less than 0.1 percent by weight or volume of 4-Aminodiphenyl.

(b) *Definitions.* For the purposes of this section:

(1) "Absolute filter" is one capable of retaining 99.97 percent of a mono disperse aerosol of 0.3 $\mu$m particles.

(2) "Authorized employee" means an employee whose duties require him to be in the regulated area and who has been specifically assigned by the employer.

(3) "Clean change room" means a room where employees put on clean clothing and/or protective equipment in an environment free of 4-Aminodiphenyl. The clean change room shall be contiguous to and have an entry from a shower room, when the shower room facilities are otherwise required in this section.

(4) "Closed system" means an operation involving 4-Aminodiphenyl where containment prevents the release of 4-Aminodiphenyl into regulated areas, nonregulated area, or the external environment.

(5) "Decontamination" means the inactivation of 4-Aminodiphenyl or its safe disposal.

(6) "Director" means the Director, National Institute for Occupational Safety and Health, or any person directed by him or the Secretary of Health, Education, and Welfare to act for the Director.

(7) "Disposal" means the safe removal of 4-Aminodiphenyl from the work environment.

(8) "Emergency" means an unforeseen circumstance or set of circumstances resulting in the release of 4-Aminodiphenyl which may result in exposure to or contact with 4-Aminodiphenyl.

(9) "External environment" means any environment external to regulated and nonregulated areas.

(10) "Isolated system" means a fully enclosed structure other than the vessel of containment of 4-Aminodiphenyl, which is impervious to the passage of 4-Aminodiphenyl, and

which would prevent the entry of 4-Aminodiphenyl into regulated areas, nonregulated areas, or the external environment, should leakage or spillage from the vessel of containment occur.

(11) "Laboratory type hood" is a device enclosed on three sides and the top and bottom, designed and maintained so as to draw air inward at an average linear face velocity of 150 feet per minute with a minimum of 125 feet per minute; designed, constructed, and maintained in such a way that an operation involving 4-Aminodiphenyl within the hood does not require the insertion of any portion of any employee's body other than his hands and arms.

(12) "Nonregulated area" means any area under the control of the employer where entry and exit is neither restricted nor controlled.

(13) "Open-vessel system" means an operation involving 4-Aminodiphenyl in an open vessel, which is not in an isolated system, a laboratory type hood, nor in any other system affording equivalent protection against the entry of 4-Aminodiphenyl into regulated areas, nonregulated areas, or the external environment.

(14) "Protective clothing" means clothing designed to protect an employee against contact with or exposure to 4-Aminodiphenyl.

(15) "Regulated area" means an area where entry and exit is restricted and controlled.

(c) *Requirements for areas containing 4-Aminodiphenyl.* A regulated area shall be established by an employer where 4-Aminodiphenyl is manufactured, processed, used, repackaged, released, handled or stored. All such areas shall be controlled in accordance with the requirements for the following category or categories describing the operation involved: (1) *Isolated systems.* Employees working with 4-Aminodiphenyl within an isolated system, such as a "glove box" shall wash their hands and arms upon completion of the assigned task and before engaging in other activities not associated with the isolated system.

(2) *Closed system operation.* Within regulated areas where 4-Aminodiphenyl is stored in sealed containers, or contained in a closed system, including piping systems, with any sample ports or openings closed while 4-Aminodiphenyl is contained within: (i) Access shall be restricted to authorized employees only;

(ii) Employees shall be required to wash hands, forearms, face and neck upon each exit from the regulated areas, close to the point of exit and before engaging in other activities.

(3) *Open vessel sytem operations.* Open vessel system operations as defined in paragraph (b)(13) of this section are prohibited.

(4) *Transfer from a closed system, charging or discharging point operations, or otherwise opening a closed system.* In operations involving "laboratory type hoods," or in locations where 4-Aminodiphenyl is contained in an otherwise "closed system," but is transferred, charged, or discharged into other normally closed containers, the provisions of this subparagraph shall apply.

(i) Access shall be restricted to authorized employees only;

(ii) Each operation shall be provided with continuous local exhaust ventilation so that air movement is always from ordinary work areas to the operation. Exhaust air shall not be discharged to regulated areas, nonregulated areas or the external environment unless decontaminated. Clean makeup air shall be introduced in sufficient volume to maintain the correct operation of the local exhaust system.

(iii) Employees shall be provided with, and required to wear, clean, full body protective clothing (smocks, coveralls, or long-sleeved shirt and pants), shoe covers and gloves prior to entering the regulated area.

(iv) Employees engaged in 4-Aminodiphenyl handling operations shall be provided with and required to wear and use a half-face, filter-type respirator for dusts, mists, and fumes, in accordance with § 1910.134. A respirator affording higher levels of protection may be substituted.

(v) Prior to each exit from a regulated area, employees shall be required to remove and leave protective clothing and equipment at the point of exit and at the last exit of the day, to place used clothing and equipment in impervious containers at the point of exit for purposes of decontamination or disposal. The contents of such impervious containers shall be identified, as required under paragraphs (e) (2), (3), and (4) of this section.

(vi) Employees shall be required to wash hands, forearms, face and neck on each exit from the regulated area, close to the point of exit, and before engaging in other activities.

(vii) Employees shall be required to shower after the last exit of the day.

(viii) Drinking fountains are prohibited in the regulated area.

(5) *Maintenance and decontamination activities.* In cleanup of leaks or spills, maintenance or repair operations on contaminated systems or equipment, where direct contact with 4-Aminodiphenyl could result, each authorized employee entering that area shall: (i) Be provided with and required to wear clean, impervious garments, including gloves, boots and continuous-air supplied hood in accordance with § 1910.134.

(ii) Be decontaminated before removing the protective garments and hood;

(iii) Be required to shower upon removing the protective garments and hood.

(6) *Laboratory activities.* [Deleted]

(d) *General regulated area requirements*—(1) *Employee identification.* A daily roster of employees entering regulated areas shall be established and maintained. The rosters, or a summary of the rosters, shall be retained for a period of 20 years. The rosters and/or summaries shall be provided upon request to authorized representatives of the Assistant Secretary and the Director. In the event that the employer ceases business without a successor, rosters shall be forwarded by registered mail to the Director.

(2) *Emergencies.* In an emergency, immediate measures including, but not limited to, the requirements of subdivisions (i), (ii), (iii), (iv), and (v) of this paragraph shall be implemented.

(i) The potentially affected area shall be evacuated as soon as the emergency has been determined.

(ii) Hazardous conditions created by the emergency shall be eliminated and the potentially affected area shall be decontaminated prior to the resumption of normal operations.

(iii) Special medical surveillance by a physician shall be instituted within 24 hours for employees present in the potentially affected area at the time of the emergency. A report of the medical surveillance and any treatment shall be included in the incident report, in accordance with paragraph (f)(2) of this section.

(iv) Where an employee has a known contact with 4-Aminodiphenyl such employee shall be required to shower as soon as possible, unless contraindicated by physical injuries.

(v) An incident report on the emergency shall be reported as provided in paragraph (f)(2) of this section.

(3) *Hygiene facilities and practices.* (i) Storage or consumption of food, storage or use of containers of beverages, storage or application of cosmetics, smoking, storage of smoking materials, tobacco products or other products for chewing, or the chewing of such products, are prohibited in regulated areas.

(ii) Where employees are required by this section to wash, washing facilities shall be provided in accordance with § 1910.141(d) (1) and (2) (ii) through (vii).

(iii) Where employees are required by this section to shower, shower facilities shall be provided in accordance with § 1910.141(d)(3).

(iv) Where employees wear protective clothing and equipment clean change rooms shall be provided, in accordance with § 1910.141(e), for the

number of such employees required to change clothes.

(v) Where toilets are in regulated areas, such toilets shall be in a separate room.

(4) *Contamination control.* (i) Regulated areas, except for outdoor systems, shall be maintained under pressure negative with respect to nonregulated areas. Local exhaust ventilation may be used to satisfy this requirement. Clean makeup air in equal volume shall replace air removed.

(ii) Any equipment, materials, or other item taken into or removed from a regulated area shall be done so in a manner that does not cause contamination in nonregulated areas or the external environment.

(iii) Decontamination procedures shall be established and implemented to remove 4-Aminodiphenyl from the surfaces of materials, equipment and the decontamination facility.

(iv) Dry sweeping and dry mopping are prohibited.

(e) *Signs, information and training*—(1) *Signs.* (i) Entrances to regulated areas shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT

AUTHORIZED PERSONNEL ONLY

(ii) Entrances to regulated areas containing operations covered in paragraph (c)(5) of this section shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT
EXPOSED IN THIS AREA

IMPERVIOUS SUIT INCLUDING GLOVES, BOOTS, AND AIR-SUPPLIED HOOD REQUIRED AT ALL TIMES

AUTHORIZED PERSONNEL ONLY

(iii) Appropriate signs and instructions shall be posted at the entrance to, and exit from, regulated areas, informing employees of the procedures that must be followed in entering and leaving a regulated area.

(2) *Container contents identification.* (i) Containers of 4-Aminodiphenyl and containers required under paragraphs (c)(4)(v) and (c)(6)(vii)(*b*), and (c)(6)(viii)(*b*) of this section which are accessible only to, and handled only by, authorized employees, or by other employees trained in accordance with subparagraph (5) of this paragraph, may have contents identification limited to a generic or proprietary name, or other proprietary identification, of the carcinogen and percent.

(ii) Containers of 4-Aminodiphenyl and containers required under paragraphs (c)(4)(v), (c)(6)(vii)(*b*), and (c)(6)(viii)(*b*) of this section which are accessible to, or handled by, employees other than authorized employees or employees trained in accordance with subparagraph (5) of this paragraph shall have contents identification which includes the full chemical name and Chemical Abstracts Service Registry number as listed in paragraph (a)(1) of this section.

(iii) Containers shall have the warning words "CANCER-SUSPECT AGENT" displayed immediately under or adjacent to the contents identification.

(iv) Containers which have 4-Aminodiphenyl contents with corrosive or irritating properties shall have label statements warning of such hazards, noting, if appropriate, particularly sensitive or affected portions of the body.

(3) *Lettering.* Lettering on signs and instructions required by subparagraph (1) shall be a minimum letter height of 2 inches. Labels on containers required under this section shall not be less than ½ the size of the largest lettering on the package, and not less than 8 point type in any instance: *Provided,* That no such required lettering need be more than 1 inch in height.

(4) *Prohibited statements.* No statement shall appear on or near any required sign, label, or instruction which contradicts or detracts from the effect of any required warning, information or instruction.

(5) *Training and indoctrination.* (i) Each employee prior to being authorized to enter a regulated area, shall receive a training and indoctrination program including, but not necessarily limited to:

(*a*) The nature of the carcinogenic hazards of 4-Aminodiphenyl, including local and systemic toxicity;

(*b*) The specific nature of the operation involving 4-Aminodiphenyl which could result in exposure;

(*c*) The purpose for and application of the medical surveillance program, including, as appropriate, methods of self-examination;

(*d*) The purpose for and application of decontamination practices and purposes;

(*e*) The purpose for and significance of emergency practices and procedures;

(*f*) The employee's specific role in emergency procedures;

(*g*) Specific information to aid the employee in recognition and evaluation of conditions and situations which may result in the release of 4-Aminodiphenyl;

(*h*) The purpose for and application of specific first aid procedures and practices;

(*i*) A review of this section at the employee's first training and indoctrination program and annually thereafter.

(ii) Specific emergency procedures shall be prescribed, and posted, and employees shall be familiarized with their terms, and rehearsed in their application.

(iii) All materials relating to the program shall be provided upon request to authorized representatives of the Assistant Secretary and the Director.

(f) *Reports*—(1) *Operations.* Not later than March 1, 1974, the information required in subparagraphs (i), (ii), (iii), and (iv) of this paragraph shall be reported in writing to the nearest OSHA Area Director. Any changes in such information shall be similarly reported in writing within 15 calendar days of such change.

(i) A brief description and in-plant location of the area(s) regulated and the address of each regulated area;

(ii) The name(s) and other identifying information as to the presence of 4-Aminodiphenyl in each regulated area;

(iii) The number of employees in each regulated area, during normal operations including maintenance activities; and

(iv) The manner in which 4-Aminodiphenyl is present in each regulated area; e.g. whether it is manufactured, processed, used, repackaged, released, stored, or otherwise handled.

(2) *Incidents.* Incidents which result in the release of 4-Aminodiphenyl into any area where employees may be potentially exposed shall be reported in accordance with this subparagraph.

(i) A report of the occurrence of the incident and the facts obtainable at that time including a report on any medical treatment of affected employees shall be made within 24 hours to the nearest OSHA Area Director.

(ii) A written report shall be filed with the nearest OSHA Area Director within 15 calendar days thereafter and shall include:

(*a*) A specification of the amount of material released, the amount of time involved, and an explanation of the procedure used in determining this figure;

(*b*) A description of the area involved, and the extent of known and possible employee exposure and area contamination; and

(*c*) A report of any medical treatment of affected employees, and any medical surveillance program implemented; and

(*d*) An analysis of the circumstances of the incident, and measures taken or to be taken, with specific completion dates, to avoid further similar releases.

(g) *Medical surveillance.* At no cost to the employee, a program of medical surveillance shall be established and implemented for employees considered for assignment to enter regulated areas, and for authorized employees.

(1) *Examinations.* (i) Before an employee is assigned to enter a regulated area, a preassignment physical examination by a physician shall be pro-

vided. The examination shall include the personal history of the employee, family and occupational background, including genetic and environmental factors.

(ii) Authorized employees shall be provided periodic physical examinations, not less often than annually, following the preassignment examination.

(iii) In all physical examinations, the examining physician shall consider whether there exist conditions of increased risk, including reduced immunological competence, those undergoing treatment with steroids or cytotoxic agents, pregnancy and cigarette smoking.

(2) *Records.* (i) Employers of employees examined pursuant to this paragraph shall cause to be maintained complete and accurate records of all such medical examinations. Records shall be maintained for the duration of the employee's employment. Upon termination of the employee's employment, including retirement or death, or in the event that the employer ceases business without a successor, records, or notarized true copies thereof, shall be forwarded by registered mail to the Director.

(ii) Records required by this paragraph shall be provided upon request to authorized representatives of the Assistant Secretary or the Director; and upon request of an employee or former employee, to a physician designated by the employee or to a new employer.

(iii) Any physician who conducts a medical examination required by this paragraph shall furnish to the employer a statement of the employee's suitability for employment in the specific exposure.

§ 1910.1012 Ethyleneimine.

(a) *Scope and application.* (1) This section applies to any area in which Ethyleneimine, Chemical Abstracts Service Registry Number 151564 is manufactured, processed, repackaged, released, handled, or stored, but shall not apply to transshipment in sealed containers, except for the labeling requirements under paragraphs (e) (2), (3), and (4) of this section.

(2) This section shall not apply to solid or liquid mixtures containing less than 1.0 percent by weight or volume of Ethyleneimine.

(b) *Definitions.* For the purposes of this section: (1) "Absolute filter" is one capable of retaining 99.97 percent of a mono disperse aerosol of 0.3 μm particles.

(2) "Authorized employee" means an employee whose duties require him to be in the regulated area and who has been specifically assigned by the employer.

(3) "Clean change room" means a room where employees put on clean clothing and/or protective equipment in an environment free of Ethyleneimine. The clean change room shall be contiguous to and have an entry from a shower room, when the shower room facilities are otherwise required in this section.

(4) "Closed system" means an operation involving Ethyleneimine where containment prevents the release of Ethyleneimine into regulated areas, nonregulated areas, or the external environment.

(5) "Decontamination" means the inactivation of Ethyleneimine or its safe disposal.

(6) "Director" means the Director, National Institute for Occupational Safety and Health, or any person directed by him or the Secretary of Health, Education, and Welfare to act for the Director.

(7) "Disposal" means the safe removal of Ethyleneimine from the work environment.

(8) "Emergency" means an unforeseen circumstance or set of circumstances resulting in the release of Ethyleneimine which may result in exposure to or contact with Ethyleneimine.

(9) "External environment" means any environment external to regulated and nonregulated areas.

(10) "Isolated system" means a fully enclosed structure other than the vessel of containment of Ethyleneimine, which is impervious to the passage of Ethyleneimine, and which would prevent the entry of Ethyleneimine into regulated areas, nonregulated areas, or the external environment, should leakage or spillage from the vessel of containment occur.

(11) "Laboratory type hood" is a device enclosed on three sides and the top and bottom, designed and maintained so as to draw air inward at an average linear face velocity of 150 feet per minute with a minimum of 125 feet per minute; designed, constructed, and maintained in such a way that an operation involving Ethyleneimine within the hood does not require the insertion of any portion of any employee's body other than his hands and arms.

(12) "Nonregulated area" means any area under the control of the employer where entry and exit is neither restricted nor controlled.

(13) "Open-vessel system" means an operation involving Ethyleneimine in an open vessel, which is not in an isolated system, a laboratory type hood, nor in any other system affording equivalent protection against the entry of Ethyleneimine into regulated areas, nonregulated areas, or the external environment.

(14) "Protective clothing" means clothing designed to protect an employee against contact with or exposure to Ethyleneimine.

(15) "Regulated area" means an area where entry and exit is restricted and controlled.

(c) *Requirements for areas containing Ethyleneimine.* A regulated area shall be established by an employer where Ethyleneimine is manufactured, processed, used, repackaged, released, handled or stored. All such areas shall be controlled in accordance with the requirements for the following category or categories describing the operation involved:

(1) *Isolated systems.* Employees working with Ethyleneimine within an isolated system, such as a "glove box" shall wash their hands and arms upon completion of the assigned task and before engaging in other activities not associated with the isolated system.

(2) *Closed system operation.* Within regulated areas where Ethyleneimine is stored in sealed containers, or contained in a closed system, including piping systems, with any sample ports or openings closed while Ethyleneimine is contained within: Access shall be restricted to authorized employees only.

(3) *Open vessel system operations.* Open vessel system operations as defined in paragraph (b)(13) of this section are prohibited.

(4) *Transfer from a closed system, charging or discharging point operations, or otherwise opening a closed system.* In operations involving "laboratory type hoods," or in locations where Ethyleneimine is contained in an otherwise "closed system," but is transferred, charged, or discharged into other normally closed containers, the provisions of this subparagraph shall apply.

(i) Access shall be restricted to authorized employees only;

(ii) Each operation shall be provided with continuous local exhaust ventilation so that air movement is always from ordinary work areas to the operation. Exhaust air shall not be discharged to regulated areas, nonregulated areas or the external environment unless decontaminated. Clean makeup air shall be introduced in sufficient volume to maintain the correct operation of the local exhaust system.

(iii) Employees shall be provided with, and required to wear, clean, full body protective clothing (smocks, coveralls, or long-sleeved shirt and pants), and gloves prior to entering the regulated area.

(iv) Employees engaged in Ethyleneimine handling operations shall be provided with and required to wear and use a full-face, supplied air respirator, of the continuous flow or pressure-demand type, in accordance with § 1910.134.

(v) Prior to each exit from a regulated area, employees shall be required to remove and leave protective clothing and equipment at the point of exit and at the last exit of the day, to place used clothing and equipment in impervious containers at the point of exit for purposes of decontamination or disposal. The contents of such impervious containers shall be identified, as required under paragraphs (e) (2), (3), and (4) of this section.

(vi) Drinking fountains are prohibited in the regulated area.

(5) *Maintenance and decontamination activities.* In cleanup of leaks or spills, maintenance or repair operations on contaminated systems or equipment, where direct contact with Ethyleneimine could result, each authorized employee entering that area shall: (i) Be provided with and required to wear clean, impervious garments, including gloves, boots and continuous-air supplied hood in accordance with § 1910.134.

(ii) Be decontaminated before removing the protective garments and hood;

(iii) Be required to shower upon removing the protective garments and hood.

(6) *Laboratory activities.* [Deleted]

(d) *General regulated area requirements*—(1) *Employee identification.* A daily roster of employees entering regulated areas shall be established and maintained. The rosters or a summary of the rosters, shall be retained for a period of 20 years. The rosters and/or summaries shall be provided upon request to authorized representatives of the Assistant Secretary and the Director. In the event that the employer ceases business without a successor, rosters shall be forwarded by registered mail to the Director.

(2) *Emergencies.* In an emergency, immediate measures including, but not limited to, the requirements of subdivisions (i), (ii), (iii), (iv), and (v) of this paragraph shall be implemented.

(i) The potentially affected area shall be evacuated as soon as the emergency has been determined.

(ii) Hazardous conditions created by the emergency shall be eliminated and the potentially affected area shall be decontaminated prior to the resumption of normal operations.

(iii) Special medical surveillance by a physician shall be instituted within 24 hours for employees present in the potentially affected area at the time of the emergency. A report of the medical surveillance and any treatment shall be included in the incident report, in accordance with paragraph (f)(2) of this section.

(iv) Where an employee has a known contact with Ethyleneimine, such employee shall be required to shower as soon as possible, unless contraindicated by physical injuries.

(v) An incident report on the emergency shall be reported as provided in paragraph (f)(2) of this section.

(vi) Emergency deluge showers and eyewash fountains supplied with running potable water shall be located near, within sight of, and on the same level with locations where a direct exposure of Ethyleneimine would be most likely as a result of equipment failure, or improper work practices.

(3) *Hygiene facilities and practices.* (i) Storage or consumption of food, storage or use of containers of beverages, storage or application of cosmetics, smoking, storage of smoking materials, tobacco products or other products for chewing, or the chewing of such products, are prohibited in regulated areas.

(ii) Where employees wear protective clothing and equipment clean change rooms shall be provided, in accordance with § 1910.141(e), for the number of such employees required to change clothes.

(iii) Where toilets are in regulated areas, such toilets shall be in a separate room.

(iv) Where employees are required by this section to wash, washing facilities shall be provided in accordance with § 1910.141(d) (1) and (2) (ii) through (vii).

(v) Where employees are required by this section to shower, shower facilities shall be provided in accordance with § 1910.141(d)(3).

(4) *Contamination control.* (i) Regulated areas, except for outdoor systems, shall be maintained under pressure negative with respect to nonregulated areas. Local exhaust ventilation may be used to satisfy this requirement. Clean makeup air in equal volume shall replace air removed.

(ii) Any equipment, material, or other item taken into or removed from a regulated area shall be done so in a manner that does not cause contamination in nonregulated areas or the external environment.

(iii) Decontamination procedures shall be established and implemented to remove Ethyleneimine from the surfaces of materials, equipment and the decontamination facility.

(e) *Signs, information and training*—(1) *Signs.* (i) Entrances to regulated areas shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT

AUTHORIZED PERSONNEL ONLY

(ii) Entrances to regulated areas containing operations covered in paragraph (c)(5) of this section shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT
EXPOSED IN THIS AREA

IMPERVIOUS SUIT INCLUDING GLOVES, BOOTS, AND AIR-SUPPLIED HOOD REQUIRED AT ALL TIMES

AUTHORIZED PERSONNEL ONLY

(iii) Appropriate signs and instructions shall be posted at the entrance to, and exit from, regulated areas, informing employees of the procedures that must be followed in entering and leaving a regulated area.

(2) *Container contents identification.* (i) Containers of Ethyleneimine and containers required under paragraphs (c)(4)(v) and (c)(6)(vii)(*b*), and (c)(6)(viii)(*b*) of this section which are accessible only to, and handled only by, authorized employees, or by other employees trained in accordance with subparagraph (5) of this paragraph may have contents identification limited to a generic or proprietary name, or other proprietary identification, of the carcinogen and percent.

(ii) Containers of Ethyleneimine and containers required under paragraphs (c)(4)(v), (c)(6)(vii)(*b*), and (c)(6)(viii)(*b*) of this section which are accessible to, or handled by employees other than authorized employees or employees trained in accordance with subparagraph (5) of this paragraph shall have contents identification which includes the full chemical name and Chemical Abstracts Service Registry number as listed in paragraph (a)(1) of this section.

(iii) Containers shall have the warning words "CANCER-SUSPECT AGENT" displayed immediately under or adjacent to the contents identification.

(iv) Containers which have Ethyleneimine contents with corrosive or irritating properties shall have label statements warning of such hazards, noting, if appropriate, particularly sensitive or affected portions of the body.

(3) *Lettering.* Lettering on signs and instructions required by subparagraph (1) shall be a minimum letter height of 2 inches. Labels on containers required under this section shall not be less than ½ the size of the largest lettering on the package, and not less than 8 point type in any instance: *Provided,* That no such required lettering need be more than 1 inch in height.

(4) *Prohibited statements.* No statement shall appear on or near any required sign, label, or instruction which contradicts or detracts from the effect of any required warning, information or instruction.

(5) *Training and indoctrination.* (i) Each employee prior to being authorized to enter a regulated area, shall receive a training and indoctrination

program including, but not necessarily limited to:

(a) The nature of the carcinogenic hazards of Ethyleneimine, including local and systemic toxicity;

(b) The specific nature of the operation involving Ethyleneimine which could result in exposure;

(c) The purpose for and application of the medical surveillance program, including, as appropriate, methods of self-examination;

(d) The purpose for and application of decontamination practices and purposes;

(e) The purpose for and significance of emergency practices and procedures;

(f) The employee's specific role in emergency procedures;

(g) Specific information to aid the employee in recognition and evaluation of conditions and situations which may result in the release of Ethyleneimine;

(h) The purpose for and application of specific first aid procedures and practices;

(i) A review of this section at the employee's first training and indoctrination program and annually thereafter.

(ii) Specific emergency procedures shall be prescribed, and posted, and employees shall be familiarized with their terms, and rehearsed in their application.

(iii) All materials relating to the program shall be provided upon request to authorized representatives of the Assistant Secretary and the Director.

(f) *Reports*—(1) *Operations.* Not later than March 1, 1974, the information required in subparagraphs (i), (ii), (iii), and (iv) of this paragraph shall be reported in writing to the nearest OSHA Area Director. Any changes in such information shall be similarly reported in writing within 15 calendar days of such change.

(i) A brief description and in-plant location of the area(s) regulated and the address of each regulated area;

(ii) The name(s) and other identifying information as to the presence of Ethyleneimine in each regulated area;

(iii) The number of employees in each regulated area, during normal operations including maintenance activities; and

(iv) The manner in which Ethyleneimine is present in each regulated area; e.g. whether it is manufactured, processed, used, repackaged, released, stored, or otherwise handled.

(2) *Incidents.* Incidents which result in the release of Ethyleneimine into any area where employees may be potentially exposed shall be reported in accordance with this subparagraph.

(i) A report of the occurrence of the incident and the facts obtainable at that time including a report on any medical treatment of affected employees shall be made within 24 hours to the nearest OSHA Area Director.

(ii) A written report shall be filed with the nearest OSHA Area Director within 15 calendar days thereafter and shall include:

(a) A specification of the amount of material released, the amount of time involved, and an explanation of the procedure used in determining this figure;

(b) A description of the area involved, and the extent of known and possible employee exposure and area contamination; and

(c) A report of any medical treatment of affected employees, and any medical surveillance program implemented; and

(d) An analysis of the circumstances of the incident, and measures taken or to be taken, with specific completion dates, to avoid further similar releases.

(g) *Medical surveillance.* At no cost to the employee, a program of medical surveillance shall be established and implemented for employees considered for assignment to enter regulated areas, and for authorized employees.

(1) *Examinations.* (i) Before an employee is assigned to enter a regulated area, a preassignment physical examination by a physician shall be provided. The examination shall include the personal history of the employee, family and occupational background, including genetic and environmental factors.

(ii) Authorized employees shall be provided periodic physical examinations, not less often than annually, following the preassignment examination.

(iii) In all physical examinations, the examining physician shall consider whether there exist conditions of increased risk, including reduced immunological competence, those undergoing treatment with steroids or cytotoxic agents, pregnancy and cigarette smoking.

(2) *Records.* (i) Employers of employees examined pursuant to this paragraph shall cause to be maintained complete and accurate records of all such medical examinations. Records shall be maintained for the duration of the employee's employment. Upon termination of the employee's employment, including retirement or death, or in the event that the employer ceases business without a successor, records, or notarized true copies thereof, shall be forwarded by registered mail to the Director.

(ii) Records required by this paragraph shall be provided upon request to authorized representatives of the Assistant Secretary or the Director; and upon request of an employee or former employee, to a physician designated by the employee or to a new employer.

(iii) Any physician who conducts a medical examination required by this paragraph shall furnish to the employer a statement of the employee's suitability for employment in the specific exposure.

**§ 1910.1013 beta-Propiolactone.**

(a) *Scope and application.* (1) This section applies to any area in which beta-Propiolactone, Chemical Abstracts Service Registry Number 57578 is manufactured, processed, repackaged, released, handled, or stored, but shall not apply to trans-shipment in sealed containers, except for the labeling requirements under paragraphs (e) (2), (3), and (4) of this section.

(2) This section shall not apply to solid or liquid mixtures containing less than 1.0 percent by weight or volume of beta-Propiolactone.

(b) *Definitions.* For the purposes of this section: (1) "Absolute filter" is one capable of retaining 99.97 percent of a mono disperse aerosol of 0.3 um particles.

(2) "Authorized employee" means an employee whose duties require him to be in the regulated area and who has been specifically assigned by the employer.

(3) "Clean change room" means a room where employees put on clean clothing and/or protective equipment in an environment free of beta-Propiolactone. The clean change room shall be contiguous to and have an entry from a shower room, when the shower room facilities are otherwise required in this section.

(4) "Closed system" means an operation involving beta-Propiolactone where containment prevents the release of beta-Propiolactone into regulated areas, nonregulated areas, or the external environment.

(5) "Decontamination" means the inactivation of beta-Propiolactone or its safe disposal.

(6) "Director" means the Director, National Institute for Occupational Safety and Health, or any person directed by him or the Secretary of Health, Education, and Welfare to act for the Director.

(7) "Disposal" means the safe removal of beta-Propiolactone from the work environment.

(8) "Emergency" means an unforeseen circumstance or set of circumstances resulting in the release of beta-Propiolactone which may result in exposure to or contact with beta-Propiolactone.

(9) "External environment" means any environment external to regulated and nonregulated areas.

(10) "Isolated system" means a fully enclosed structure other than the vessel of containment of beta-Propio-

lactone, which is impervious to the passage of beta-Propiolactone, and which would prevent the entry of beta-Propiolactone into regulated areas, nonregulated areas, or the external environment, should leakage or spillage from the vessel of containment occur.

(11) "Laboratory type hood" is a device enclosed on three sides and the top and bottom, designed and maintained so as to draw air inward at an average linear face velocity of 150 feet per minute with a minimum of 125 feet per minute; designed, constructed, and maintained in such a way that an operation involving beta-Propiolactone within the hood does not require the insertion of any portion of any employee's body other than his hands and arms.

(12) "Nonregulated area" means any area under the control of the employer where entry and exit is neither restricted nor controlled.

(13) "Open-vessel system" means an operation involving beta-Propiolactone in an open vessel, which is not in an isolated system, a laboratory type hood, nor in any other system affording equivalent protection against the entry of beta-Propiolactone into regulated areas, nonregulated areas, or the external environment.

(14) "Protective clothing" means clothing designed to protect an employee against contact with or exposure to beta-Propiolactone.

(15) "Regulated area" means an area where entry and exit is restricted and controlled.

(c) *Requirements for areas containing beta-Propiolactone.* A regulated area shall be established by an employer where beta-Propiolactone is manufactured, processed, used, repackaged, released, handled or stored. All such areas shall be controlled in accordance with the requirements for the following category or categories describing the operation involved:

(1) *Isolated systems.* Employees working with beta-Propiolactone within an isolated system, such as a "glove box" shall wash their hands and arms upon completion of the assigned task and before engaging in other activities not associated with the isolated system.

(2) *Closed system operation.* Within regulated areas where beta-Propiolactone is stored in sealed containers, or contained in a closed system, including piping systems, with any sample ports or openings closed while beta-Propiolactone is contained within. Access shall be restricted to authorized employees only.

(3) *Open vessel system operations.* Open vessel system operations as defined in paragraph (b)(13) of this section are prohibited.

(4) *Transfer from a closed system, charging or discharging point operations, or otherwise opening a closed system.* In operations involving "laboratory type hoods," or in locations where beta-Propiolactone is contained in an otherwise "closed system," but is transferred, charged, or discharged into other normally closed containers, the provisions of this subparagraph shall apply.

(i) Access shall be restricted to authorized employees only;

(ii) Each operation shall be provided with continuous local exhaust ventilation so that air movement is always from ordinary work areas to the operation. Exhaust air shall not be discharged to regulated areas, nonregulated areas or the external environment unless decontaminated. Clean makeup air shall be introduced in sufficient volume to maintain the correct operation of the local exhaust system.

(iii) Employees shall be provided with, and required to wear, clean, full body protective clothing (smocks, coveralls, or long-sleeved shirt and pants), shoe covers and gloves prior to entering the regulated area.

(iv) Employees engaged in beta-Propiolactone handling operations shall be provided with and required to wear and use a full-face, supplied air respirator, of the continuous flow or pressure-demand type, in accordance with § 1910.134.

(v) Prior to each exit from a regulated area, employees shall be required to remove and leave protective clothing and equipment at the point of exit and at the last exit of the day, to place used clothing and equipment in impervious containers at the point of exit for purposes of decontamination or disposal. The contents of such impervious containers shall be identified, as required under paragraphs (e) (2), (3), and (4) of this section.

(vi) Drinking fountains are prohibited in the regulated area.

(5) *Maintenance and decontamination activities.* In cleanup of leaks or spills, maintenance or repair operations on contaminated systems or equipment, where direct contact with beta-Propiolactone could result, each authorized employee entering that area shall:

(i) Be provided with and required to wear clean, impervious garments, including gloves, boots and continuous-air supplied hood in accordance with § 1910.134.

(ii) Be decontaminated before removing the protective garments and hood;

(iii) Be required to shower upon removing the protective garments and hood.

(6) *Laboratory activities.* [Deleted]

(d) *General regulated area requirements*—(1) *Employee identification.* A daily roster of employees entering regulated areas shall be established and maintained. The rosters or a summary of the rosters shall be retained for a period of 20 years. The rosters and/or summaries shall be provided upon request to authorized representatives of the Assistant Secretary and the Director. In the event that the employer ceases business without a successor, rosters shall be forwarded by registered mail to the Director.

(2) *Emergencies.* In an emergency, immediate measures including, but not limited to, the requirements of subdivisions (i), (ii), (iii), (iv), and (v) of this section shall be implemented.

(i) The potentially affected area shall be evacuated as soon as the emergency has been determined.

(ii) Hazardous conditions created by the emergency shall be eliminated and the potentially affected area shall be decontaminated prior to the resumption of normal operations.

(iii) Special medical surveillance by a physician shall be instituted within 24 hours for employees present in the potentially affected area at the time of the emergency. A report of the medical surveillance and any treatment shall be included in the incident report, in accordance with paragraph (f)(2) of this section.

(iv) Where an employee has a known contact with beta-Propiolactone, such employee shall be required to shower as soon as possible, unless contraindicated by physical injuries.

(v) An incident report on the emergency shall be reported as provided in paragraph (f)(2) of this section.

(vi) Emergency deluge showers and eyewash fountains supplied with running potable water shall be located near, within sight of, and on the same level with locations where a direct exposure to beta-Propiolactone would be most likely as a result of equipment failure, or improper work practice.

(3) *Hygiene facilities and practices.* (i) Storage or consumption of food, storage or use of containers of beverages, storage or application of cosmetics, smoking, storage of smoking materials, tobacco products or other products for chewing, or the chewing of such products, are prohibited in regulated areas.

(ii) Where employees wear protective clothing and equipment clean change rooms shall be provided, in accordance with § 1910.141(e), for the number of such employees required to change clothes.

(iii) Where toilets are in regulated areas, such toilets shall be in a separate room.

(iv) Where employees are required by this section to wash, washing facilities shall be provided in accordance with § 1910.141(d)(1) and (2) (ii) through (vii).

(v) Where employees are required by this section to shower, shower facilities shall be provided in accordance with § 1910.141(d)(3).

(4) *Contamination control.* (i) Regulated areas, except for outdoor systems, shall be maintained under pressure negative with respect to nonregulated areas. Local exhaust ventilation may be used to satisfy this requirement. Clean makeup air in equal volume shall replace air removed.

(ii) Any equipment, material, or other item taken into or removed from a regulated area shall be done so in a manner that does not cause contamination in nonregulated areas or the external environment.

(iii) Decontamination procedures shall be established and implemented to remove beta-Propiolactone from the surfaces of materials, equipment and the decontamination facility.

(e) *Signs, information and training*—(1) *Signs.* (i) Entrances to regulated areas shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT

AUTHORIZED PERSONNEL ONLY

(ii) Entrances to regulated areas containing operations covered in paragraph (c)(5) of this section shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT
EXPOSED IN THIS AREA

IMPERVIOUS SUIT INCLUDING GLOVES, BOOTS, AND AIR-SUPPLIED HOOD REQUIRED AT ALL TIMES

AUTHORIZED PERSONNEL ONLY

(iii) Appropriate signs and instructions shall be posted at the entrance to, and exit from, regulated areas, informing employees of the procedures that must be followed in entering and leaving a regulated area.

(2) *Container contents identification.* (i) Containers of beta-Propiolactone and containers required under paragraphs (c)(4)(v) and (c)(6)(vii)(*b*), and (c)(6)(viii)(*b*) of this section which are accessible only to, and handled only by, authorized employees, or by other employees trained in accordance with subparagraph (5) of this paragraph, may have contents identification limited to a generic or proprietary name, or other proprietary identification, of the carcinogen and percent.

(ii) Containers of beta-Propiolactone and containers required under paragraphs (c)(4)(v), (c)(6)(vii)(*b*), and (c)(6)(viii)(*b*) of this section which are accessible to, or handled by, employees other than authorized employees or employees trained in accordance with subparagraph (5) of this paragraph shall have contents identification which includes the full chemical name and Chemical Abstracts Service Registry number as listed in paragraph (a)(1) of this section.

(iii) Containers shall have the warning words "CANCER-SUSPECT AGENT" displayed immediately under or adjacent to the contents identification.

(iv) Containers which have beta-Propiolactone contents with corrosive or irritating properties shall have label statements warning of such hazards, noting, if appropriate, particularly sensitive or affected portions of the body.

(3) *Lettering.* Lettering on signs and instructions required by subparagraph (1) shall be a minimum letter height of 2 inches. Labels on containers required under this section shall not be less than ½ the size of the largest lettering on the package, and not less than 8 point type in any instance: *Provided,* that no such required lettering need be more than 1 inch in height.

(4) *Prohibited statements.* No statement shall appear on or near any required sign, label, or instruction which contradicts or detracts from the effect of any required warning, information or instruction.

(5) *Training and indoctrination.* (i) Each employee prior to being authorized to enter a regulated area, shall receive a training and indoctrination program including, but not necessarily limited to:

(*a*) The nature of the carcinogenic hazards of beta-Propiolactone, including local and systemic toxicity;

(*b*) The specific nature of the operation involving beta-Propiolactone which could result in exposure;

(*c*) The purpose for and application of the medical surveillance program, including, as appropriate, methods of self-examination;

(*d*) The purpose for and application of decontamination practices and purposes;

(*e*) The purpose for and significance of emergency practices and procedures;

(*f*) The employee's specific role in emergency procedures;

(*g*) Specific information to aid the employee in recognition and evaluation of conditions and situations which may result in the release of beta-Propiolactone;

(*h*) The purpose for and application of specific first aid procedures and practices;

(*i*) A review of this section at the employee's first training and indoctrination program and annually thereafter.

(ii) Specific emergency procedures shall be prescribed, and posted, and employees shall be familiarized with their terms, and rehearsed in their application.

(iii) All materials relating to the program shall be provided upon request to authorized representatives of the Assistant Secretary and the Director.

(f) *Reports*—(1) *Operations.* Not later than March 1, 1974, the information required in subparagraphs (i), (ii), (iii), and (iv) of this paragraph shall be reported in writing to the nearest OSHA Area Director. Any changes in such information shall be similarly reported in writing within 15 calendar days of such change. (i) A brief description and in-plant location of the area(s) regulated and the address of each regulated area;

(ii) The name(s) and other identifying information as to the presence of beta-Propiolactone in each regulated area;

(iii) The number of employees in each regulated area, during normal operations including maintenance activities; and

(iv) The manner in which beta-Propiolactone is present in each regulated area; e.g. whether it is manufactured, processed, used, repackaged, released, stored, or otherwise handled.

(2) *Incidents.* Incidents which result in the release of beta-Propiolactone into any area where employees may be potentially exposed shall be reported in accordance with this subparagraph. (i) A report of the occurrence of the incident and the facts obtainable at that time including a report on any medical treatment of affected employees shall be made within 24 hours to the nearest OSHA Area Director.

(ii) A written report shall be filed with the nearest OSHA Area Director within 15 calendar days thereafter and shall include:

(*a*) A specification of the amount of material released, the amount of time involved, and an explanation of the procedure used in determining this figure;

(*b*) A description of the area involved, and the extent of known and possible employee exposure and area contamination; and

(*c*) A report of any medical treatment of affected employees, and any medical surveillance program implemented; and

(*d*) An analysis of the circumstances of the incident, and measures taken or to be taken, with specific completion dates, to avoid further similar releases.

(g) *Medical surveillance.* At no cost to the employee, a program of medical surveillance shall be established and implemented for employees considered for assignment to enter regulated areas, and for authorized employees.

(1) *Examinations.* (i) Before an employee is assigned to enter a regulated area, a preassignment physical examination by a physician shall be provided. The examination shall include the personal history of the employee,

family and occupational background, including genetic and environmental factors.

(ii) Authorized employees shall be provided periodic physical examinations, not less often than annually, following the preassignment examination.

(iii) In all physical examinations, the examining physician shall consider whether there exist conditions of increased risk, including reduced immunological competence, those undergoing treatment with steroids or cytotoxic agent, pregnancy and cigarette smoking.

(2) *Records.* (i) Employers of employees examined pursuant to this paragraph shall cause to be maintained complete and accurate records of all such medical examinations. Records shall be maintained for the duration of the employee's employment. Upon termination of the employee's employment, including retirement or death, or in the event that the employer ceases business without a successor, records, or notarized true copies thereof, shall be forwarded by registered mail to the Director.

(ii) Records required by this paragraph shall be provided upon request to authorized representatives of the Assistant Secretary or the Director; and upon request of an employee or former employee, to a physician designated by the employee or to a new employer.

(iii) Any physician who conducts a medical examination required by this paragraph shall furnish to the employer a statement of the employee's suitability for employment in the specific exposure.

§ 1910.1014 2-Acetylaminofluorene.

(a) *Scope and application.* (1) This section applies to any area in which 2-Acetylaminofluorene, Chemical Abstracts Service Registry Number 53963 is manufactured, processed, repackaged, released, handled, or stored, but shall not apply to trans-shipment in sealed containers, except for the labeling requirements under paragraphs (e)(2), (3), and (4) of this section.

(2) This section shall not apply to solid or liquid mixtures containing less than 1.0 percent by weight or volume of 2-Acetylaminofluorene.

(b) *Definitions.* For the purposes of this section: (1) "Absolute filter" is one capable of retaining 99.97 percent of a mono disperse aerosol of 0.3 $\mu$m particles.

(2) "Authorized employee" means an employee whose duties require him to be in the regulated area and who has been specifically assigned by the employer.

(3) "Clean change room" means a room where employees put on clean clothing and/or protective equipment in an environment free of 2-Acetylaminofluorene. The clean change room shall be contiguous to and have an entry from a shower room, when the shower room facilities are otherwise required in this section.

(4) "Closed system" means an operation involving 2-Acetylaminofluorene where containment prevents the release of 2-Acetylaminofluorene into regulated areas, nonregulated areas, or the external environment.

(5) "Decontamination" means the inactivation of 2-Acetylaminofluorene or its safe disposal.

(6) "Director" means the Director, National Institute for Occupational Safety and Health, or any person directed by him or the Secretary of Health, Education, and Welfare to act for the Director.

(7) "Disposal" means the safe removal of 2-Acetylaminofluorene from the work environment.

(8) "Emergency" means an unforeseen circumstance or set of circumstances resulting in the release of 2-Acetylaminofluorene which may result in exposure to or contact with 2-Acetylaminofluorene.

(9) "External environment" means any environment external to regulated and nonregulated areas.

(10) "Isolated system" means a fully enclosed structure other than the vessel of containment of 2-Acetylaminofluorene, which is impervious to the passage of 2-Acetylaminofluorene, and which would prevent the entry of 2-Acetylaminofluorene into regulated areas, nonregulated areas, or the external environment, should leakage or spillage from the vessel of containment occur.

(11) "Laboratory type hood" is a device enclosed on three sides and the top and bottom, designed and maintained so as to draw air inward at an average linear face velocity of 150 feet per minute with a minimum of 125 feet per minute; designed, constructed, and maintained in such a way that an operation involving 2-Acetylaminoflourene within the hood does not require the insertion of any portion of any employee's body other than his hands and arms.

(12) "Nonregulated area" means any area under the control of the employer where entry and exit is neither restricted nor controlled.

(13) "Open-vessel system" means an operation involving 2-Acetylaminofluorene in an open vessel, which is not in an isolated system, a laboratory type hood, nor in any other system affording equivalent protection against the entry of 2-Acetylaminofluorene into regulated areas, nonregulated areas, or the external environment.

(14) "Protective clothing" means clothing designed to protect an employee against contact with or exposure to 2-Acetylaminofluorene.

(15) "Regulated area" means an area where entry and exit is restricted and controlled.

(c) *Requirements for areas containing 2-Acetylaminofluorene.* A regulated area shall be established by an employer where 2-Acetylaminofluorene is manufactured, processed, used, repackaged, released, handled or stored. All such areas shall be controlled in accordance with the requirements for the following category or categories describing the operation involved: (1) *Isolated systems.* Employees working with 2-Acetylaminofluorene within an isolated system, such as a "glove box" shall wash their hands and arms upon completion of the assigned task and before engaging in other activities not associated with the isolated system.

(2) *Closed system operation.* Within regulated areas where 2-Acetylaminofluorene is stored in sealed containers, or contained in a closed system, including piping systems, with any sample ports or openings closed while 2-Acetylaminofluorene is contained within:

(i) Access shall be restricted to authorized employees only;

(ii) Employees shall be required to wash hands, forearms, face and neck upon each exit from the regulated areas, close to the point of exit and before engaging in other activities.

(3) *Open vessel system operations.* Open vessel system operations as defined in paragraph (b)(13) of this section are prohibited.

(4) *Transfer from a closed system, charging or discharging point operations, or otherwise opening a closed system.* In operations involving "laboratory type hoods," or in locations where 2-Acetylaminofluorene is contained in an otherwise "closed system," but is transferred, charged, or discharged into other normally closed containers, the provisions of this subparagraph shall apply.

(i) Access shall be restricted to authorized employees only;

(ii) Each operation shall be provided with continuous local exhaust ventilation so that air movement is always from ordinary work areas to the operation. Exhaust air shall not be discharged to regulated areas, nonregulated areas or the external environment unless decontaminated. Clean makeup air shall be introduced in sufficient volume to maintain the correct operation of the local exhaust system.

(iii) Employees shall be provided with, and required to wear, clean, full body protective clothing (smocks, coveralls, or long-sleeved shirt and pants), shoe covers and gloves prior to entering the regulated area.

(iv) Employees engaged in 2-Acetylaminofluorene handling operations

shall be provided with and required to wear and use a half-face, filter-type respirator for dusts, mists, and fumes, in accordance with § 1910.134. A respirator affording higher levels of protection may be substituted.

(v) Prior to each exit from a regulated area, employees shall be required to remove and leave protective clothing and equipment at the point of exit and at the last exit of the day, to place used clothing and equipment in impervious containers at the point of exit for purposes of decontamination or disposal. The contents of such impervious containers shall be identified, as required under paragraphs (e)(2), (3), and (4) of this section.

(vi) Employees shall be required to wash hands, forearms, face and neck on each exit from the regulated area, close to the point of exit, and before engaging in other activities.

(vii) Employees shall be required to shower after the last exit of the day.

(viii) Drinking fountains are prohibited in the regulated area.

(5) *Maintenance and decontamination activities.* In cleanup of leaks or spills, maintenance or repair operations on contaminated systems or equipment, where direct contact with 2-Acetylaminofluorene could result, each authorized employee entering that area shall:

(i) Be provided with and required to wear clean, impervious garments, including gloves, boots and continuous-air supplied hood in accordance with § 1910.134.

(ii) Be decontaminated before removing the protective garments and hood;

(iii) Be required to shower upon removing the protective garments and hood.

(6) *Laboratory activities*—[deleted]

(d) *General regulated area requirements*—(1) *Employee identification.* A daily roster of employees entering regulated areas shall be established and maintained. The rosters or a summary of the rosters shall be retained for a period of 20 years. The rosters and/or summaries shall be provided upon request to authorized representatives of the Assistant Secretary and the Director. In the event that the employer ceases business without a successor, rosters shall be forwarded by registered mail to the Director.

(2) *Emergencies.* In an emergency, immediate measures including, but not limited to, the requirements of subdivisions (i), (ii), (iii), (iv), and (v) of this paragraph shall be implemented.

(i) The potentially affected area shall be evacuated as soon as the emergency has been determined.

(ii) Hazardous conditions created by the emergency shall be eliminated and the potentially affected area shall be decontaminated prior to the resumption of normal operations.

(iii) Special medical surveillance by a physician shall be instituted within 24 hours for employees present in the potentially affected area at the time of the emergency. A report of the medical surveillance and any treatment shall be included in the incident report, in accordance with paragraph (f)(2) of this section.

(iv) Where an employee has a known contact with 2-Acetylaminofluorene, such employee shall be required to shower as soon as possible, unless contraindicated by physical injuries.

(v) An incident report on the emergency shall be reported as provided in paragraph (f)(2) of this section.

(3) *Hygiene facilities and practices.* (i) Storage or consumption of food, storage or use of containers of beverages, storage or application of cosmetics, smoking, storage of smoking materials, tobacco products or other products for chewing, or the chewing of such products, are prohibited in regulated areas.

(ii) Where employees are required by this section to wash, washing facilities shall be provided in accordance with § 1910.141(d)(1) and (2)(ii) through (vii).

(iii) Where employees are required by this section to shower, shower facilities shall be provided in accordance with § 1910.141(d)(3).

(iv) Where employees wear protective clothing and equipment clean change rooms shall be provided, in accordance with § 1910.141(e), for the number of such employees required to change clothes.

(v) Where toilets are in regulated areas, such toilets shall be in a separate room.

(4) *Contamination control.* (i) Regulated areas, except for outdoor systems, shall be maintained under pressure negative with respect to nonregulated areas. Local exhaust ventilation may be used to satisfy this requirement. Clean makeup air in equal volume shall replace air removed.

(ii) Any equipment, materials, or other item taken into or removed from a regulated area shall be done so in a manner that does not cause contamination in nonregulated areas or the external environment.

(iii) Decontamination procedures shall be established and implemented to remove 2-Acetylaminofluorene from the surfaces of materials, equipment and the decontamination facility.

(iv) Dry sweeping and dry mopping are prohibited.

(e) *Signs, information and training*—(1) *Signs.* (i) Entrances to regulated areas shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT

AUTHORIZED PERSONNEL ONLY

(ii) Entrances to regulated areas containing operations covered in paragraph (c)(5) of this section shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT
EXPOSED IN THIS AREA

IMPERVIOUS SUIT INCLUDING GLOVES, BOOTS, AND AIR-SUPPLIED HOOD REQUIRED AT ALL TIMES

AUTHORIZED PERSONNEL ONLY

(iii) Appropriate signs and instructions shall be posted at the entrance to, and exit from, regulated areas, informing employees of the procedures that must be followed in entering and leaving a regulated area.

(2) *Container contents identification.* (i) Containers of 2-Acetylaminofluorene and containers required under paragraphs (c)(4)(v) and (c)(6)(vii)(*b*), and (c)(6)(viii)(*b*) of this section which are accessible only to, and handled only by, authorized employees, or by other employees trained in accordance with subparagraph (5) of this paragraph, may have contents identification, limited to a generic or proprietary name, or other proprietary identification, of the carcinogen and percent.

(ii) Containers of 2-Acetylaminofluorene and containers required under paragraphs (c)(4)(v), (c)(6)(vii)(*b*), and (c)(6)(viii)(*b*) of this section which are accessible to, or handled by, employees other than authorized employees or employees trained in accordance with subparagraph (5) of this paragraph shall have contents identification which includes the full chemical name and Chemical Abstracts Service Registry number as listed in paragraph (a)(1) of this section.

(iii) Containers shall have the warning words "CANCER-SUSPECT AGENT" displayed immediately under or adjacent to the contents identification.

(iv) Containers which have 2-Acetylaminofluorene contents with corrosive or irritating properties shall have label statements warning of such hazards, noting, if appropriate, particularly sensitive or affected portions of the body.

(3) *Lettering.* Lettering on signs and instructions required by subparagraph (1) shall be a minimum letter height of 2 inches. Labels on containers required under this section shall not be less than ½ the size of the largest lettering on the package, and not less than 8 point type in any instance; *Provided,* That no such required lettering need be more than 1 inch in height.

(4) *Prohibited statements.* No statement shall appear on or near any required sign, label, or instruction which contradicts or detracts from the effect of any required warning, information or instruction.

(5) *Training and indoctrination.* (i) Each employee prior to being authorized to enter a regulated area, shall receive a training and indoctrination program including, but not necessarily limited to:

(*a*) The nature of the carcinogenic hazards of 2-Acetylaminofluorene, including local and systemic toxicity;

(*b*) The specific nature of the operation involving 2-Acetylaminofluorene which could result in exposure;

(*c*) The purpose for and application of the medical surveillance program, including, as appropriate, methods of self-examination;

(*d*) The purpose for and application of decontamination practices and purposes;

(*e*) The purpose for and significance of emergency practices and procedures;

(*f*) The employee's specific role in emergency procedures;

(*g*) Specific information to aid the employee in recognition and evaluation of conditions and situations which may result in the release of 2-Acetylaminofluorene;

(*h*) The purpose for and application of specific first aid procedures and practices;

(*i*) A review of this section at the employee's first training and indoctrination program and annually thereafter.

(ii) Specific emergency procedures shall be prescribed, and posted, and employees, shall be familiarized with their terms, and rehearsed in their application.

(iii) All materials relating to the program shall be provided upon request to authorized representatives of the Assistant Secretary and the Director.

(f) *Reports*—(1) *Operations.* Not later than March 1, 1974, the information required in paragraphs (f)(1) (i), (ii), (iii), and (iv) of this section shall be reported in writing to the nearest OSHA Area Director. Any changes in such information shall be similarly reported in writing within 15 calendar days of such change. (i) A brief description and in-plant location of the area(s) regulated and the address of each regulated area;

(ii) The name(s) and other identifying information as to the presence of 2-Acetylaminofluorene in each regulated area;

(iii) The number of employees in each regulated area, during normal operations including maintenance activities; and

(iv) The manner in which 2-Acetylaminofluorene is present in each regulated area; e.g. whether it is manufactured, processed, used, repackaged, released, stored, or otherwise handled.

(2) *Incidents.* Incidents which result in the release of 2-Acetylaminofluorene into any area where employees may be potentially exposed shall be reported in accordance with this subparagraph. (i) A report of the occurrence of the incident and the facts obtainable at that time including a report on any medical treatment of affected employees shall be made within 24 hours to the nearest OSHA Area Director.

(ii) A written report shall be filed with the nearest OSHA Area Director within 15 calendar days thereafter and shall include:

(*a*) A specification of the amount of material released, the amount of time involved, and an explanation of the procedure used in determining this figure;

(*b*) A description of the area involved, and the extent of known and possible employee exposure and area contamination; and

(*c*) A report of any medical treatment of affected employees, and any medical surveillance program implemented; and

(*d*) An analysis of the circumstances of the incident, and measures taken or to be taken, with specific completion dates, to avoid further similar releases.

(g) *Medical surveillance.* At no cost to the employee, a program of medical surveillance shall be established and implemented for employees considered for assignment to enter regulated areas, and for authorized employees.

(1) *Examinations.* (i) Before an employee is assigned to enter a regulated area, a preassignment physical examination by a physician shall be provided. The examination shall include the personal history of the employee, family and occupational background, including genetic and environmental factors.

(ii) Authorized employees shall be provided periodic physical examinations, not less often than annually, following the preassignment examination.

(iii) In all physical examinations, the examining physician shall consider whether there exist conditions of increased risk, including reduced immunological competence, those undergoing treatment with steroids or cytotoxic agents, pregnancy and cigarette smoking.

(2) *Records.* (i) Employers of employees examined pursuant to this paragraph shall cause to be maintained complete and accurate records of all such medical examinations. Records shall be maintained for the duration of the employee's employment. Upon termination of the employee's employment, including retirement or death, or in the event that the employer ceases business without a successor, records, or notarized true copies thereof, shall be forwarded by registered mail to the Director.

(ii) Records required by this paragraph shall be provided upon request to authorized representatives of the Assistant Secretary or the Director; and upon request of an employee or former employee, to a physician designated by the employee or to a new employer.

(iii) Any physician who conducts a medical examination required by this paragraph shall furnish to the employer a statement of the employee's suitability for employment in the specific exposure.

### § 1910.1015 4-Dimethylaminoazobenzene.

(a) *Scope and application.* (1) This section applies to any area in which 4-Dimethylaminoazobenzene, Chemical Abstracts Service Registry Number 60117 is manufactured, processed, repackaged, released, handled, or stored, but shall not apply to trans-shipment in sealed containers, except for the labeling requirements under paragraphs (e) (2), (3), and (4) of this section.

(2) This section shall not apply to solid or liquid mixtures containing less than 1.0 percent by weight or volume of 4-Dimethylaminoazobenzene.

(b) *Definitions.* For the purposes of this section: (1) "Absolute filter" is one capable of retaining 99.97 percent of a mono disperse aerosol of 0.3 $\mu$m particles.

(2) "Authorized employee" means an employee whose duties require him to be in the regulated area and who has been specifically assigned by the employer.

(3) "Clean change room" means a room where employees put on clean clothing and/or protective equipment in an environment free of 4-Dimethylaminoazobenzene. The clean change room shall be contiguous to and have an entry from a shower room, when the shower room facilities are otherwise required in this section.

(4) "Closed system" means an operation involving 4-Dimethylaminoazobenzene where containment prevents the release of 4-Dimethylaminoazobenzene into regulated areas, nonregulated areas, or the external environment.

(5) "Decontamination" means the inactivation of 4-Dimethylaminoazobenzene or its safe disposal.

(6) "Director" means the Director, National Institute for Occupational Safety and Health, or any person directed by him or the Secretary of Health, Education, and Welfare to act for the Director.

(7) "Disposal" means the safe removal of 4-Dimethylaminoazobenzene from the work environment.

(8) "Emergency" means an unforeseen circumstance or set of circumstances resulting in the release of 4-Dimethylaminoazobenzene which may result in exposure to or contact with 4-Dimethylaminoazobenzene.

(9) "External environment" means any environment external to regulated and nonregulated areas.

(10) "Isolated system" means a fully enclosed structure other than the vessel of containment of 4-Dimethylaminoazobenzene, which is impervious to the passage of 4-Dimethylaminoazobenzene which would prevent the entry of 4-Dimethylaminoazobenzene into regulated areas, nonregulated areas, or the external environment, should leakage or spillage from the vessel of containment occur.

(11) "Laboratory type hood" is a device enclosed on three sides and the top and bottom, designed and maintained so as to draw air inward at an average linear face velocity of 150 feet per minute with a minimum of 125 feet per minute; designed, constructed, and maintained in such a way that an operation involving 4-Dimethylaminoazobenzene within the hood does not require the insertion of any portion of any employee's body other than his hands and arms.

(12) "Nonregulated area" means any area under the control of the employer where entry and exit is neither restricted nor controlled.

(13) "Open-vessel system" means an operation involving 4-Dimethylaminoazobenzene in an open vessel, which is not in an isolated system, a laboratory type hood, nor in any other system affording equivalent protection against the entry of 4-Dimethylaminoazobenzene into regulated areas, nonregulated areas, or the external environment.

(14) "Protective clothing" means clothing designed to protect an employee against contact with or exposure to 4-Dimethylaminoazobenzene.

(15) "Regulated area" means an area where entry and exit is restricted and controlled.

(c) *Requirements for areas containing 4-Dimethylaminoazobenzene.* A regulated area shall be established by an employer where 4-Dimethylaminoazobenzene is manufactured, processed, used, repackaged, released, handled or stored. All such areas shall be controlled in accordance with the requirements for the following category or categories describing the operation involved: (1) *Isolated systems.* Employees working with 4-Dimethylaminoazobenzene within an isolated system, such as a "glove box" shall wash their hands and arms upon completion of the assigned task and before engaging in other activities not associated with the isolated system.

(2) *Closed system operation.* Within regulated areas where 4-Dimethylaminoazobenzene is stored in sealed containers, or contained in a closed system, including piping systems, with any sample ports or openings closed while 4-Dimethylaminoazobenzene is contained within: (i) Access shall be restricted to authorized employees only;

(ii) Employees shall be required to wash hands, forearms, face and neck upon each exit from the regulated areas, close to the point of exit and before engaging in other activities.

(3) *Open vessel system operations.* Open vessel system operations as defined in paragraph (b)(13) of this section are prohibited.

(4) *Transfer from a closed system, charging or discharging point operations, or otherwise opening a closed system.* In operations involving "laboratory type hoods," or in locations where 4-Dimethylaminoazobenzene is contained in an otherwise "closed system," but is transferred, charged, or discharged into other normally closed containers, the provisions of this subparagraph shall apply.

(i) Access shall be restricted to authorized employees only;

(ii) Each operation shall be provided with continuous local exhaust ventilation so that air movement is always from ordinary work areas to the operation. Exhaust air shall not be discharged to regulated areas, nonregulated areas or the external environment unless decontaminated. Clean makeup air shall be introduced in sufficient volume to maintain the correct operation of the local exhaust system.

(iii) Employees shall be provided with, and required to wear, clean, full body protective clothing (smocks, coveralls, or long-sleeved shirt and pants), shoe covers, and gloves prior to entering the regulated area.

(iv) Employees engaged in 4-Dimethylaminoazobenzene handling operations shall be provided with and required to wear and use a half-face, filter-type respirator for dusts, mists, and fumes, in accordance with § 1910.134. A respirator affording higher levels of protection may be substituted.

(v) Prior to each exit from a regulated area, employees shall be required to remove and leave protective clothing and equipment at the point of exit and at the last exit of the day, to place used clothing and equipment in impervious containers at the point of exit for purposes of decontamination or disposal. The contents of such impervious containers shall be identified, as required under paragraphs (e) (2), (3), and (4) of this section.

(vi) Employees shall be required to wash hands, forearms, face and neck on each exit from the regulated area, close to the point of exit, and before engaging in other activities.

(vii) Employees shall be required to shower after the last exist of the day.

(viii) Drinking fountains are prohibited in the regulated area.

(5) *Maintenance and decontamination activities.* In cleanup of leaks or spills, maintenance or repair operations on contaminated systems or equipment, where direct contact with 4-Dimethylaminoazobenzene could result, each authorized employee entering that area shall: (i) Be provided with and required to wear clean, impervious garments, including gloves, boots and continuous-air supplied hood in accordance with § 1910.134.

(ii) Be decontaminated before removing the protective garments and hood;

(iii) Be required to shower upon removing the protective garments and hood.

(6) *Laboratory activities.* [Deleted]

(d) *General regulated area requirements*—(1) *Employee identification.* A daily roster of employees entering regulated areas shall be established and maintained. The rosters or a summary of the rosters, shall be retained for a period of 20 years. The rosters and/or summaries shall be provided upon request to authorized representatives of the Assistant Secretary and the Director. In the event that the employer ceases business without a successor, rosters shall be forwarded by registered mail to the Director.

(2) *Emergencies.* In an emergency, immediate measures including, but not limited to, the requirements of subdivisions (i), (ii), (iii), (iv), and (v) of this paragraph shall be implemented.

(i) The potentially affected area shall be evacuated as soon as the emergency has been determined.

(ii) Hazardous conditions created by the emergency shall be eliminated and the potentially affected area shall be decontaminated prior to the resumption of normal operations.

(iii) Special medical surveillance by a physician shall be instituted within 24 hours for employees present in the potentially affected area at the time of the emergency. A report of the medical surveillance and any treatment shall be included in the incident report, in accordance with paragraph (f)(2) of this section.

(iv) Where an employee has a known contact with 4-Dimethylamino- azobenzene, such employee shall be required to shower as soon as possible, unless contraindicated by physical injuries.

(v) An incident report on the emergency shall be reported as provided in paragraph (f)(2) of this section.

(3) *Hygiene facilities and practices.* (i) Storage or consumption of food, storage or use of containers of beverages, storage or application of cosmetics, smoking, storage of smoking materials, tobacco products or other products for chewing, or the chewing of such products, are prohibited in regulated areas.

(ii) Where employees are required by this section to wash, washing facilities shall be provided in accordance with § 1910.141(d)(1) and (2)(ii) through (vii).

(iii) Where employees are required by this section to shower, shower facilities shall be provided in accordance with § 1910.141(d)(3).

(iv) Where employees wear protective clothing and equipment clean change room shall be provided, in accordance with § 1910.141(e), for the number of such employees required to change clothes.

(v) Where toilets are in regulated areas, such toilets shall be in a separate room.

(4) *Contamination control.* (i) Regulated areas, except for outdoor systems, shall be maintained under pressure negative with respect to nonregulated areas. Local exhaust ventilation may be used to satisfy this requirement. Clean makeup air in equal volume shall replace air removed.

(ii) Any equipment, material, or other item taken into or removed from a regulated area shall be done so in a manner that does not cause contamination in nonregulated areas or the external environment.

(iii) Decontamination procedures shall be established and implemented to remove 4-Dimethylamino- azobenzene from the surfaces of materials, equipment and the decontamination facility.

(iv) Dry sweeping and dry mopping are prohibited.

(e) *Signs, information and training*—(1) *Signs.* (i) Entrances to regulated areas shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT

AUTHORIZED PERSONNEL ONLY

(ii) Entrances to regulated areas containing operations covered in paragraph (c)(5) of this section shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT
EXPOSED IN THIS AREA

IMPERVIOUS SUIT INCLUDING GLOVES, BOOTS, AND AIR-SUPPLIED HOOD REQUIRED AT ALL TIMES

AUTHORIZED PERSONNEL ONLY

(iii) Appropriate signs and instructions shall be posted at the entrance to, and exit from, regulated areas, informing employees of the procedures that must be followed in entering and leaving a regulated area.

(2) *Container contents identification.* (i) Containers of 4-Dimethylaminoazobenzene and containers required under paragraphs (c)(4)(v) and (c)(6)(vii)(*b*), and (c)(6)(viii)(*b*) of this section which are accessible only to, and handled only by, authorized employees, or by other employees trained in accordance with subparagraph (5) of this paragraph, may have contents identification limited to a generic or proprietary name, or other proprietary identification, of the carcinogen and percent.

(ii) Containers of 4-Dimethylaminoazobenzene and containers required under paragraphs (c)(4)(v), (c)(6)(vii)(*b*), and (c)(6)(viii)(*b*) of this section which are accessible to, or handled by employees other than authorized employees or employees trained in accordance with subparagraph (5) of this paragraph shall have contents identification which includes the full chemical name and Chemical Abstracts Service Registry number as listed in paragraph (a)(1) of this section.

(iii) Containers shall have the warning words "CANCER-SUSPECT AGENT" displayed immediately under or adjacent to the contents identification.

(iv) Containers which have 4-Dimethylaminoazobenzene contents with corrosive or irritating properties shall have label statements warning of such hazards, noting, if appropriate, particularly sensitive or affected portions of the body.

(3) *Lettering.* Lettering on signs and instructions required by subparagraph (1) of this paragraph shall be a minimum letter height of 2 inches. Labels on containers required under this section shall not be less than ½ the size of the largest lettering on the package, and not less than 8 point type in any instance; provided that no such required lettering need be more than 1 inch in height.

(4) *Prohibited statements.* No statement shall appear on or near any required sign, label, or instruction which contradicts or detracts from the effect of any required warning, information or instruction.

(5) *Training and indoctrination.* (i) Each employee prior to being authorized to enter a regulated area, shall receive a training and indoctrination program including, but not necessarily limited to:

(*a*) The nature of the carcinoginic hazards of 4-Dimethylamino-azobenzene, including local and sytemic toxicity;

(*b*) The specific nature of the operation involving 4-Dimethylaminoazobenzene which could result in exposure;

(*c*) The purpose for the application of the medical surveillance program, including, as appropriate, methods of self-examination;

(*d*) The purpose for and application of decontamination practices and purposes;

(*e*) The purpose for and significance of emergency practices and procedures;

(*f*) The employee's specific role in emergency procedures;

(*g*) Specific information to aid the employee in recognition and evaluation of conditions and situations which may result in the release of 4-Dimethylaminoazobenzene;

(*h*) The purpose for and application of specific first aid procedures and practices;

(*i*) A review of this section at the employee's first training and indoctrination program and annually thereafter.

(ii) Specific emergency procedures shall be prescribed, and posted, and employees shall be familiarized with their terms, and rehearsed in their application.

(iii) All materials relating to the program shall be provided upon request to authorized representatives of the Assistant Secretary and the Director.

(f) *Reports*—(1) *Operations.* Not later than March 1, 1974, the information required in subparagraphs (i), (ii), (iii), and (iv) of this paragraph shall be reported in writing to the nearest OSHA Area Director. Any changes in such information shall be similarly reported in writing within 15 calendar days of such change. (i) A brief description and in-plant location of the area(s) regulated and the address of each regulated area;

(ii) The name(s) and other identifying information as to the presence of 4-Dimethylaminoazobenzene in each regulated area;

(iii) The number of employees in each regulated area, during normal operations including maintenance activities; and

(iv) The manner in which 4-Dimethyaminoazobenzene is present in each regulated area; e.g. whether it is manufactured, processed, used, repackaged, released, stored, or otherwise handled.

(2) *Incidents.* Incidents which result in the release of 4-Dimethylaminoazobenzene into any area where employees may be potentially exposed shall be reported in accordance with this subparagraph.

(i) A report of the occurrence of the incident and the facts obtainable at that time including a report on any medical treatment of affected employees shall be made within 24 hours to the nearest OSHA Area Director.

(ii) A written report shall be filed with the nearest OSHA Area Director

within 15 calendar days thereafter and shall include:

(a) A specification of the amount of material released, the amount of time involved, and an explanation of the procedure used in determining this figure;

(b) A description of the area involved, and the extent of known and possible employee exposure and area contamination; and

(c) A report of any medical treatment of affected employees, and any medical surveillance program implemented; and

(d) An analysis of the circumstances of the incident, and measures taken or to be taken, with specific completion dates, to avoid further similar releases.

(g) *Medical surveillance.* At no cost to the employee, a program of medical surveillance shall be established and implemented for employees considered for assignment to enter regulated areas, and for authorized employees.

(1) *Examinations.* (i) Before an employee is assigned to enter a regulated area, a preassignment physical examination by a physician shall be provided. The examination shall include the personal history of the employee, family and occupational background, including genetic and environmental factors.

(ii) Authorized employees shall be provided periodic physical examinations, not less often than annually, following the preassignment examination.

(iii) In all physical examinations, the examining physician shall consider whether there exist conditions of increased risk, including reduced immunological competence, those undergoing treatment with steroids or cytotoxic agents, pregnancy and cigarette smoking.

(2) *Records.* (i) Employers of employees examined pursuant to this paragraph shall cause to be maintained complete and accurate records of all such medical examination. Records shall be maintained for the duration of the employee's employment. Upon termination of the employee's employment, including retirement or death, or in the event that the employer ceases business without a successor, records, or notarized true copies thereof, shall be forwarded by registered mail to the Director.

(ii) Records required by this paragraph shall be provided upon request to authorized representatives of the Assistant Secretary or the Director; and upon request of an employee or former employee, to a physician designated by the employee or to a new employer.

(iii) Any physician who conducts a medical examination required by this paragraph shall furnish to the employer a statement of the employee's suitability for employment in the specific exposure.

**§ 1910.1016 N-Nitrosodimethylamine.**

(a) *Scope and application.* (1) This section applies to any area in which N-Nitrosodimethylamine, Chemical Abstracts Service Registry Number 62759 is manufactured, processed, repackaged, released, handled, or stored, but shall not apply to trans-shipment in sealed containers, except for the labeling requirements under paragraphs (e) (2), (3), and (4) of this section.

(2) This section shall not apply to solid or liquid mixtures containing less than 1.0% by weight or volume of N-Nitrosodimethylamine.

(b) *Definitions.* For the purposes of this section: (1) "Absolute filter" is one capable of retaining 99.97 percent of a mono disperse aerosol of 0.3 μm particles.

(2) "Authorized employee" means an employee whose duties require him to be in the regulated area and who has been specifically assigned by the employer.

(3) "Clean change room" means a room where employees put on clean clothing and/or protective equipment in an environment free of N-Nitrosodimethylamine. The clean change room shall be contiguous to and have an entry from a shower room, when the shower room facilities are otherwise required in this section.

(4) "Closed system" means an operation involving N-Nitrosodimethylamine where containment prevents the release of N-Nitrosodimethylamine into regulated areas, nonregulated areas, or the external environment.

(5) "Decontamination" means the inactivation of N-Nitrosodimethylamine or its safe disposal.

(6) "Director" means the Director, National Institute for Occupational Safety and Health, or any person directed by him or the Secretary of Health, Education, and Welfare to act for the Director.

(7) "Disposal" means the safe removal of N-Nitrosodimethylamine from the work environment.

(8) "Emergency" means circumstance or set of circumstances resulting in the release of N-Nitrosodimethylamine which may result in exposure to or contact with N-Nitrosodimethylamine.

(9) "External environment" means any environment external to regulated and nonregulated areas.

(10) "Isolated system" means a fully enclosed structure other than the vessel of containment of N-Nitrosodimethylamine, which is impervious to the passage of N-Nitrosodimethylamine, and which would prevent the entry of N-Nitrosodimethylamine into regulated areas, nonregulated areas, or the external environment, should leakage or spillage from the vessel of containment occur.

(11) "Laboratory type hood" is a device enclosed on three sides and the top and bottom, designed and maintained so as to draw air inward at an average linear face velocity of 150 feet per minute with a minimum of 125 feet per minute; designed, constructed, and maintained in such a way that an operation involving N-Nitrosodimethylamine within the hood does not require the insertion of any portion of any employee's body other than his hands and arms.

(12) "Nonregulated area" means any area under the control of the employer where entry and exit is neither restricted nor controlled.

(13) "Open-vessel system" means an operation involving N-Nitrosodimethylamine in an open vessel, which is not in an isolated system, a laboratory type hood, nor in any other system affording equivalent protection against the entry of N-Nitrosodimethylamine into regulated areas, nonregulated areas, or the external environment.

(14) "Protective clothing" means clothing designed to protect an employee against contact with or exposure to N-Nitrosodimethylamine.

(15) "Regulated area" means an area where entry and exit is restricted and controlled.

(c) *Requirements for areas containing N-Nitrosodimethylamine.* A regulated area shall be established by an employer where N-Nitrosodimethylamine is manufactured, processed, used, repackaged, released, handled or stored. All such areas shall be controlled in accordance with the requirements for the following category or categories describing the operation involved: (1) *Isolated systems.* Employees working with N-Nitrosodimethylamine within an isolated system, such as a "glove box" shall wash their hands and arms upon completion of the assigned task and before engaging in other activities not associated with the isolated system.

(2) *Closed system operation.* Within regulated areas where N-Nitrosodimethylamine is stored in sealed containers, or contained in a closed system, including piping systems, with any sample ports or openings closed while N-Nitrosodimethylamine is contained within:

(i) Access shall be restricted to authorized employees only;

(ii) Employees shall be required to wash hands, forearms, face and neck upon each exit from the regulated areas, close to the point of exit and before engaging in other activities.

(3) *Open vessel system operations.* Open vessel system operations as de-

fined in paragraph (b)(13) of this section are prohibited.

(4) *Transfer from a closed system, charging or discharging point operations, or otherwise opening a closed system.* In operations involving "laboratory type hoods," or in locations where N-Nitrosodimethylamine is contained in an otherwise "closed system," but is transferred, charged, or discharged into other normally closed containers, the provisions of this subparagraph shall apply.

(i) Access shall be restricted to authorized employees only;

(ii) Each operation shall be provided with continuous local exhaust ventilation so that air movement is always from ordinary work areas to the operation. Exhaust air shall not be discharged to regulated areas, nonregulated areas or the external environment unless decontaminated. Clean makeup air shall be introduced in sufficient volume to maintain the correct operation of the local exhaust system.

(iii) Employees shall be provided with, and required to wear, clean, full body protective clothing (smocks, coveralls, or long-sleeved shirt and pants), shoe covers, and gloves prior to entering the regulated area.

(iv) Employees engaged in N-Nitrosodimethylamine handling operations shall be provided with and required to wear and use a half-face, filter-type respirator for dusts, mists, and fumes, in accordance with § 1910.134. A respirator affording higher levels of protection may be substituted.

(v) Prior to each exit from a regulated area, employees shall be required to remove and leave protective clothing and equipment at the point of exit and at the last exit of the day, to place used clothing and equipment in impervious containers at the point of exit for purposes of decontamination or disposal. The contents of such impervious containers shall be identified, as required under paragraphs (e)(2), (3), and (4) of this section.

(vi) Employees shall be required to wash hands, forearms, face and neck on each exit from the regulated area, close to the point of exit, and before engaging in other activities.

(vii) Employees shall be required to shower after the last exit of the day.

(viii) Drinking fountains are prohibited in the regulated area.

(5) *Maintenance and decontamination activities.* In cleanup of leaks or spills, maintenance or repair operations on contaminated systems or equipment, where direct contact with N-Nitrosodimethylamine could result, each authorized employee entering that area shall:

(i) Be provided with and required to wear clean, impervious garments, including gloves, boots and continuous-air supplied hood in accordance with § 1910.134.

(ii) Be decontaminated before removing the protective garments and hood;

(iii) Be required to shower upon removing the protective garments and hood.

(d) *General regulated area requirements*—(1) *Employee identification.* A daily roster of employees entering regulated areas shall be established and maintained. The rosters or a summary of the rosters shall be retained for a period of 20 years. The rosters and/or summaries shall be provided upon request to authorized representatives of the Assistant Secretary and the Director. In the event that the employer ceases business without a successor, rosters shall be forwarded by registered mail to the Director.

(2) *Emergencies.* In an emergency, immediate measures including, but not limited to, the requirements of subdivisions (d)(2) (i), (ii), (iii), (iv), and (v) of this paragraph shall be implemented.

(i) The potentially affected area shall be evacuated as soon as the emergency has been determined.

(ii) Hazardous conditions created by the emergency shall be eliminated and the potentially affected area shall be decontaminated prior to the resumption of normal operations.

(iii) Special medical surveillance by a physician shall be instituted within 24 hours for employees present in the potentially affected area at the time of the emergency. A report of the medical surveillance and any treatment shall be included in the incident report, in accordance with paragraph (f)(2) of this section.

(iv) Where an employee has a known contact with N-Nitrosodimethylamine, such employee shall be required to shower as soon as possible, unless contraindicated by physical injuries.

(v) An incident report on the emergency shall be reported as provided in paragraph (f)(2) of this section.

(3) *Hygiene facilities and practices.* (i) Storage or consumption of food, storage or use of containers of beverages, storage or application of cosmetics, smoking, storage of smoking materials, tobacco products or other products for chewing, or the chewing of such products, are prohibited in regulated areas.

(ii) Where employees are required by this section to wash, washing facilities shall be provided in accordance with § 1910.141(d)(1) and (2)(ii) through (vii).

(iii) Where employees are required by this section to shower, shower facilities shall be provided in accordance with § 1910.141(d)(3).

(iv) Where employees wear protective clothing and equipment clean change rooms shall be provided, in accordance with § 1910.141(e), for the number of such employees required to change clothes.

(v) Where toilets are in regulated areas, such toilets shall be in a separate room.

(4) *Contamination control.* (i) Regulated areas, except for outdoor systems, shall be maintained under pressure negative with respect to nonregulated areas. Local exhaust ventilation may be used to satisfy this requirement. Clean make-up air in equal volume shall replace air removed.

(ii) Any equipment, material, or other item taken into or removed from a regulated area shall be done so in a manner that does not cause contamination in nonregulated areas or the external environment.

(iii) Decontamination procedures shall be established and implemented to remove N-Nitrosodimethylamine from the surfaces of materials, equipment and the decontamination facility.

(iv) Dry sweeping and dry mopping are prohibited.

(e) *Signs, information and training*—(1) *Signs.* (i) Entrances to regulated areas shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT

AUTHORIZED PERSONNEL ONLY

(ii) Entrances to regulated areas containing operations covered in paragraph (c)(5) of this section shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT EXPOSED IN THIS AREA

IMPERVIOUS SUIT INCLUDING GLOVES BOOTS AND AIR-SUPPLIED HOOD REQUIRED AT ALL TIMES

AUTHORIZED PERSONNEL ONLY

(iii) Appropriate signs and instructions shall be posted at the entrance to, and exit from, regulated areas, informing employees of the procedures that must be followed in entering and leaving a regulated area.

(2) *Container contents identification.* (i) Containers of N-Nitrosodimethylamine and containers required under paragraphs (c)(4)(v) and (c)(6)(vii) (*b*), and (c)(6)(viii)(*b*) of this section which are accessible only to, and handled only by, authorized employees, or by other employees trained in accordance with subparagraph (5) of this paragraph, may have contents identification limited to a generic or proprietary name, or other proprietary identification, of the carcinogen and percent.

(ii) Containers of N-Nitrosodimethylamine and containers required under paragraphs (c)(4)(v), (c)(6)(vii)(*b*), and (c)(6)(viii)(*b*) of this

section which are accessible to, or handled by employees other than authorized employees or employees trained in accordance with subparagraph (5) of this paragraph, shall have contents identification which includes the full chemical name and Chemical Abstracts Service Registry Number as listed in paragraph (a)(1) of this section.

(iii) Containers shall have the warning words "CANCER-SUSPECT AGENT" displayed immediately under or adjacent to the contents identification.

(iv) Containers which have N-Nitrosodimethylamine contents with corrosive or irritating properties shall have label statements warning of such hazards, noting, if appropriate, particularly sensitive or affected portions of the body.

(3) *Lettering.* Lettering on signs and instructions required by subparagraph (1) shall be a minimum letter height of 2 inches. Labels on containers required under this section shall not be less than ½ the size of the largest lettering on the package, and not less than 8 point type in any instance: *Provided,* That no such required lettering need be more than 1 inch in height.

(4) *Prohibited statements.* No statement shall appear on or near any required sign, label, or instruction which contradicts or detracts from the effect of any required warning, information or instruction.

(5) *Training and indoctrination.* (i) Each employee prior to being authorized to enter a regulated area, shall receive a training and indoctrination program including, but not necessarily limited to:

(*a*) The nature of the carcinogenic hazards of N-Nitrosodimethylamine, including local and systemic toxicity;

(*b*) The specific nature of the operation involving N-Nitrosodimethylamine which could result in exposure;

(*c*) The purpose for and application of the medical surveillance program, including, as appropriate, methods of self-examination;

(*d*) The purpose of and application of decontamination practices and purposes;

(*e*) The purpose for and significance of emergency practices and procedures;

(*f*) The employee's specific role in emergency procedures;

(*g*) Specific information to aid the employee in recognition and evaluation of conditions and situations which may result in the release of N-Nitrosodimethylamine;

(*h*) The purpose for and application of specific first aid procedures and practices.

(*i*) A review of this section at the employee's first training and indoctrination program and annually thereafter.

(ii) Specific emergency procedures shall be prescribed, and posted, and employees shall be familiarized with their terms, and rehearsed in their application.

(iii) All materials relating to the program shall be provided upon request to authorized representatives of the Assistant Secretary and the Director.

(f) *Reports*—(1) *Operations.* Not later than March 1, 1974, the information required in subparagraphs (i), (ii), (iii), and (iv) of this paragraph shall be reported in writing to the nearest OSHA Area Director. Any changes in such information shall be similarly reported in writing within 15 calendar days of such change.

(i) A brief description and in-plant location of the area(s) regulated and the address of each regulated area;

(ii) The name(s) and other identifying information as to the presence of N-Nitrosodimethylamine in each regulated area;

(iii) The number of employees in each regulated area, during normal operations including maintenance activities; and

(iv) The manner in which N-Nitrosodimethylamine is present in each regulated area; e.g. whether it is manufactured, processed, used, repackaged, released, stored, or otherwise handled.

(2) *Incidents.* Incidents which result in the release of N-Nitrosodimethylamine into any area where employees may be potentially exposed shall be reported in accordance with this subparagraph.

(i) A report of the occurrence of the incident and the facts obtainable at that time including a report on any medical treatment of affected employees shall be made within 24 hours to the nearest OSHA Area Director.

(ii) A written report shall be filed with the nearest OSHA Area Director within 15 calendar days thereafter and shall include:

(*a*) A specification of the amount of material released, the amount of time involved, and an explanation of the procedure used in determining this figure;

(*b*) A description of the area involved, and the extent of known and possible employee exposure and area contamination; and

(*c*) A report of any medical treatment of affected employees, and any medical surveillance program implemented; and

(*d*) An analysis of the circumstances of the incident, and measures taken or to be taken, with specific completion dates, to avoid further similar releases.

(g) *Medical surveillance.* At no cost to the employee, a program of medical surveillance shall be established and implemented for employees considered for assignment to enter regulated areas, and for authorized employees.

(1) *Examinations.* (i) Before an employee is assigned to enter a regulated area, a preassignment physical examination by a physician shall be provided. The examination shall include the personal history of the employee, family and occupational background, including genetic and environmental factors.

(ii) Authorized employees shall be provided periodic physical examinations, not less often than annually, following the preassignment examination.

(iii) In all physical examinations, the examining physician shall consider whether there exist conditions of increased risk, including reduced immunological competence, those undergoing treatment with steroids or cytotoxic agents, pregnancy and cigarette smoking.

(2) *Records.* (i) Employers of employees examined pursuant to this paragraph shall cause to be maintained complete and accurate records of all such medical examinations. Records shall be maintained for the duration of the employee's employment. Upon termination of an employee's employment, including retirement or death, or in the event that the employer ceases business without a successor, records, or notarized true copies thereof, shall be forwarded by registered mail to the Director.

(ii) Records required by this paragraph shall be provided upon request to authorized representatives of the Assistant Secretary or the Director, and, upon request of an employee or former employee, to a physician designated by the employee or to a new employer.

(iii) Any physician who conducts a medical examination required by this paragraph shall furnish to the employer a statement of the employee's suitability for employment in the specific exposure.

**§ 1910.1017 Vinyl chloride.**

(a) *Scope and application.* (1) This section includes requirements for the control of employee exposure to vinyl chloride (chloroethene), Chemical Abstracts Service Registry No. 75014.

(2) This section applies to the manufacture, reaction, packaging, repackaging, storage, handling or use of vinyl chloride or polyvinyl chloride, but does not apply to the handling or use of fabricated products made of polyvinyl chloride.

(3) This section applies to the transportation of vinyl chloride or polyvinyl chloride except to the extent that the Department of Transportation may regulate the hazards covered by this section.

(b) *Definitions.* (1) "Action level" means a concentration of vinyl chloride of 0.5 ppm averaged over an 8-hour work day.

(2) "Assistant Secretary" means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or his designee.

(3) "Authorized person" means any person specifically authorized by the employer whose duties require him to enter a regulated area or any person entering such an area as a designated representative of employees for the purpose of exercising an opportunity to observe monitoring and measuring procedures.

(4) "Director" means the Director, National Institute for Occupational Safety and Health, U.S. Department of Health, Education, and Welfare, or his designee.

(5) "Emergency" means any occurrence such as, but not limited to, equipment failure, or operation of a relief device which is likely to, or does, result in massive release of vinyl chloride.

(6) "Fabricated product" means a product made wholly or partly from polyvinyl chloride, and which does not require further processing at temperatures, and for times, sufficient to cause mass melting of the polyvinyl chloride resulting in the release of vinyl chloride.

(7) "Hazardous operation" means any operation, procedure, or activity where a release of either vinyl chloride liquid or gas might be expected as a consequence of the operation or because of an accident in the operation, which would result in an employee exposure in excess of the permissible exposure limit.

(8) "OSHA Area Director" means the Director for the Occupational Safety and Health Administration Area Office having jurisdiction over the geographic area in which the employer's establishment is located.

(9) "Polyvinyl chloride" means polyvinyl chloride homopolymer or copolymer before such is converted to a fabricated product.

(10) "Vinyl chloride" means vinyl chloride monomer.

(c) *Permissible exposure limit.* (1) No employee may be exposed to vinyl chloride at concentrations greater than 1 ppm averaged over any 8-hour period, and

(2) No employee may be exposed to vinyl chloride at concentrations greater than 5 ppm averaged over any period not exceeding 15 minutes.

(3) No employee may be exposed to vinyl chloride by direct contact with liquid vinyl chloride.

(d) *Monitoring.* (1) A program of initial monitoring and measurement shall be undertaken in each establishment to determine if there is any employee exposed, without regard to the use of respirators, in excess of the action level.

(2) Where a determination conducted under paragraph (d)(1) of this section shows any employee exposures, without regard to the use of respirators, in excess of the action level, a program for determining exposures for each such employee shall be established. Such a program:

(i) Shall be repeated at least monthly where any employee is exposed, without regard to the use of respirators, in excess of the permissible exposure limit.

(ii) Shall be repeated not less than quarterly where any employee is exposed, without regard to the use of respirators, in excess of the action level.

(iii) May be discontinued for any employee only when at least two consecutive monitoring determinations, made not less than 5 working days apart, show exposures for that employee at or below the action level.

(3) Whenever there has been a production, process or control change which may result in an increase in the release of vinyl chloride, or the employer has any other reason to suspect that any employee may be exposed in excess of the action level, a determination of employee exposure under paragraph (d)(1) of this section shall be performed.

(4) The method of monitoring and measurement shall have an accuracy (with a confidence level of 95 percent) of not less than plus or minus 50 percent from 0.25 through 0.5 ppm, plus or minus 35 percent from over 0.5 ppm through 1.0 ppm, and plus or minus 25 percent over 1.0 ppm. (Methods meeting these accuracy requirements are available in the "NIOSH Manual of Analytical Methods").

(5) Employees or their designated representatives shall be afforded reasonable opportunity to observe the monitoring and measuring required by this paragraph.

(e) *Regulated area.* (1) A regulated area shall be established where:

(i) Vinyl chloride or polyvinyl chloride is manufactured, reacted, repackaged, stored, handled or used; and

(ii) Vinyl chloride concentrations are in excess of the permissible exposure limit.

(2) Access to regulated areas shall be limited to authorized persons. A daily roster shall be made of authorized persons who enter.

(f) *Methods of compliance.* Employee exposures to vinyl chloride shall be controlled to, at, or below the permissible exposure limit provided in paragraph (c) of this section by engineering, work practice, and personal protective controls as follows:

(1) Feasible engineering and work practice controls shall immediately be used to reduce exposures to, at, or below the permissible exposure limit.

(2) Wherever feasible engineering and work practice controls which can be instituted immediately are not sufficient to reduce exposures to, at, or below the permissible exposure limit, they shall nonetheless be used to reduce exposures to the lowest practicable level, and shall be supplemented by respiratory protection in accordance with paragraph (g) of this section. A program shall be established and implemented to reduce exposures to, at, or below the permissible exposure limit, or to the greatest extent feasible, solely by means of engineering and work practice controls, as soon as feasible.

(3) Written plans for such a program shall be developed and furnished upon request for examination and copying to authorized representatives of the Assistant Secretary and the Director. Such plans shall be updated at least every six months.

(g) *Respiratory protection.* Where respiratory protection is required under this section:

(1) The employer shall provide a respirator which meets the requirements of this paragraph and shall assure that the employee uses such respirator, except that until April 1, 1976, wearing of respirators shall be at the discretion of each employee for exposures not in excess of 25 ppm, measured over any 15-minute period. Until April 1, 1976, each employee who chooses not to wear an appropriate respirator shall be informed at least quarterly of the hazards of vinyl chloride and the purpose, proper use, and limitations of respiratory devices.

(2) Respirators shall be selected from among those jointly approved by the Mining Enforcement and Safety Administration, Department of the Interior, and the National Institute for Occupational Safety and Health under the provisions of 30 CFR Part 11.

(3) A respiratory protection program meeting the requirements of § 1910.134 shall be established and maintained.

(4) Selection of respirators for vinyl chloride shall be as follows:

| *Atmospheric concentration of vinyl chloride* | *Required apparatus* |
|---|---|
| (i) Unknown, or above 3,600 ppm | Open-circuit, self-contained breathing apparatus, pressure demand type, with full facepiece. |
| (ii) Not over 3,600 ppm | (A) Combination type C supplied air respirator, pressure demand type, with full or half facepiece, and auxiliary self-contained air supply; or |
| (iii) Not over 1,000 ppm | (B) Combination type C, supplied air respirator continuous flow type, with full or half facepiece, and auxiliary self-contained air supply.<br>Type C, supplied air respirator, continuous flow type, with full or half facepiece, helmet or hood. |
| (iv) Not over 100 ppm | (A) Combination type C supplied air respirator demand type, with full facepiece, and auxiliary self-contained air supply; or<br>(B) Open-circuit self-contained breathing apparatus with full facepiece, in demand mode; or<br>(C) Type C supplied air respirator, demand type, with full facepiece. |
| (v) Not over 25 ppm | (A) A powered air-purifying respirator with hood, helmet, full or half facepiece, and a canister which provides a service life of at least 4 hours for concentrations of vinyl chloride up to 25 ppm, or<br>(B) Gas mask, front- or back-mounted canister which provides a service life of at least 4 hours for concentrations of vinyl chloride up to 25 ppm. |
| (vi) Not over 10 ppm | (A) Combination type C supplied-air respirator, demand type, with half facepiece, and auxiliary self-contained air supply; or<br>(B) Type C supplied-air respirator, demand type, with half facepiece; or<br>(C) Any chemical cartridge respirator with an organic vapor cartridge which provides a service life of at least 1 hour for concentrations of vinyl chloride up to 10 ppm. |

(5)(i) Entry into unknown concentrations or concentrations greater than 36,000 ppm (lower explosive limit) may be made only for purposes of life rescue; and

(ii) Entry into concentrations of less than 36,000 ppm, but greater than 3,600 ppm may be made only for purposes of life rescue, firefighting, or securing equipment so as to prevent a greater hazard from release of vinyl chloride.

(6) Where air-purifying respirators are used:

(i) Air-purifying canisters or cartridges shall be replaced prior to the expiration of their service life or the end of the shift in which they are first used, whichever occurs first, and

(ii) A continuous monitoring and alarm system shall be provided where concentrations of vinyl chloride could reasonably exceed the allowable concentrations for the devices in use. Such system shall be used to alert employees when vinyl chloride concentrations exceed the allowable concentrations for the devices in use.

(7) Apparatus prescribed for higher concentrations may be used for any lower concentration.

(h) *Hazardous operations.* (1) Employees engaged in hazardous operations, including entry of vessels to clean polyvinyl chloride residue from vessel walls, shall be provided and required to wear and use:

(i) Respiratory protection in accordance with paragraphs (c) and (g) of this section; and

(ii) Protective garments to prevent skin contact with liquid vinyl chloride or with polyvinyl chloride residue from vessel walls. The protective garments shall be selected for the operation and its possible exposure conditions.

(2) Protective garments shall be provided clean and dry for each use.

(i) *Emergency situations.* A written operational plan for emergency situations shall be developed for each facility storing, handling, or otherwise using vinyl chloride as a liquid or compressed gas. Appropriate portions of the plan shall be implemented in the event of an emergency. The plan shall specifically provide that:

(1) Employees engaged in hazardous operations or correcting situations of existing hazardous releases shall be equipped as required in paragraph (h) of this section;

(2) Other employees not so equipped shall evacuate the area and not return until conditions are controlled by the methods required in paragraph (f) of this section and the emergency is abated.

(j) *Training.* Each employee engaged in vinyl chloride or polyvinyl chloride operations shall be provided training in a program relating to the hazards of vinyl chloride and precautions for its safe use.

(1) The program shall include: (i) The nature of the health hazard from chronic exposure to vinyl chloride including specifically the carcinogenic hazard;

(ii) The specific nature of operations which could result in exposure to vinyl chloride in excess of the permissible limit and necessary protective steps;

(iii) The purpose for, proper use, and limitations of respiratory protective devices;

(iv) The fire hazard and acute toxicity of vinyl chloride, and the necessary protective steps;

(v) The purpose for and a description of the monitoring program;

(vi) The purpose for, and a description of, the medical surveillance program;

(vii) Emergency procedures;

(viii) Specific information to aid the employee in recognition of conditions which may result in the release of vinyl chloride; and

(ix) A review of this standard at the employee's first training and indoctrination program, and annually thereafter.

(2) All materials relating to the program shall be provided upon request to the Assistant Secretary and the Director.

(k) *Medical surveillance.* A program of medical surveillance shall be instituted for each employee exposed, without regard to the use of respirators, to vinyl chloride in excess of the action level. The program shall provide each such employee with an opportunity for examinations and tests in accordance with this paragraph. All medical examinations and procedures shall be performed by or under the supervision of a licensed physician, and shall be provided without cost to the employee.

(1) At the time of initial assignment, or upon institution of medical surveillance;

(i) A general physical examination shall be performed, with specific attention to detecting enlargement of liver, spleen or kidneys, or dysfunction in these organs, and for abnormalities in skin, connective tissues and the pulmonary system (See Appendix A).

(ii) A medical history shall be taken, including the following topics:

(A) Alcohol intake;

(B) Past history of hepatitis;

(C) Work history and past exposure to potential hepatotoxic agents, including drugs and chemicals;

(D) Past history of blood transfusions; and

(E) Past history of hospitalizations.

(iii) A serum specimen shall be obtained and determinations made of:

(A) Total bilirubin;

(B) Alkaline phosphatase;

(C) Serum glutamic oxalacetic transaminase (SGOT);

(D) Serum glutamic pyruvic transaminase (SGPT); and

(E) Gamma glustamyl transpeptidase.

(2) Examinations provided in accordance with this paragraph shall be performed at least:

(i) Every 6 months for each employee who has been employed in vinyl chloride or polyvinyl chloride manufacturing for 10 years or longer; and

(ii) Annually for all other employees.

(3) Each employee exposed to an emergency shall be afforded appropriate medical surveillance.

(4) A statement of each employee's suitability for continued exposure to vinyl chloride including use of protective equipment and respirators, shall be obtained from the examining physician promptly after any examination. A copy of the physician's statement shall be provided each employee.

(5) If any employee's health would be materially impaired by continued exposure, such employee shall be withdrawn from possible contact with vinyl chloride.

(6) Laboratory analyses for all biological specimens included in medical examinations shall be performed in laboratories licensed under 42 CFR Part 74.

(7) If the examining physician determines that alternative medical examinations to those required by paragraph (k)(1) of this section will provide at least equal assurance of detecting medical conditions pertinent to the exposure to vinyl chloride, the employer may accept such alternative examinations as meeting the requirements of paragraph (k)(1) of this section, if the employer obtains a statement from the examining physician setting forth the alternative examinations and the rationale for substitution. This statement shall be available upon request for examination and copying to authorized representatives of the Assistant Secretary and the Director.

(l) *Signs and labels.* (1) Entrances to regulated areas shall be posted with legible signs bearing the legend:

CANCER-SUSPECT AGENT AREA
AUTHORIZED PERSONNEL ONLY

(2) Areas containing hazardous operations or where an emergency currently exists shall be posted with legible signs bearing the legend:

CANCER-SUSPECT AGENT IN THIS AREA

PROTECTIVE EQUIPMENT REQUIRED

AUTHORIZED PERSONNEL ONLY

(3) Containers of polyvinyl chloride resin waste from reactors or other waste contaminated with vinyl chloride shall be legibly labeled:

CONTAMINATED WITH VINYL CHLORIDE

CANCER-SUSPECT AGENT

(4) Containers of polyvinyl chloride shall be legibly labeled:

POLYVINYL CHLORIDE (OR TRADE NAME)
Contains
VINYL CHLORIDE
VINYL CHLORIDE IS A CANCER-SUSPECT AGENT

(5) Containers of vinyl chloride shall be legibly labeled either: (i)

VINYL CHLORIDE
EXTREMELY FLAMMABLE GAS UNDER PRESSURE
CANCER SUSPECT AGENT

or (ii) In accordance with 49 CFR Parts 170-189, with the additional legend:

CANCER-SUSPECT AGENT

applied near the label or placard.

(6) No statement shall appear on or near any required sign, label or instruction which contradicts or detracts from the effect of, any required warning, information or instruction.

(m) *Records.* (1) All records maintained in accordance with this section shall include the name and social security number of each employee where relevant.

(2) Records of required monitoring and measuring, medical records, and authorized personnel rosters, shall be made and shall be available upon request for examination and copying to authorized representatives of the Assistant Secretary and the Director.

(i) Monitoring and measuring records shall:

(A) State the date of such monitoring and measuring and the concentrations determined and identify the instruments and methods used;

(B) Include any additional information necessary to determine individual employee exposures where such exposures are determined by means other than individual monitoring of employees; and

(C) Be maintained for not less than 30 years.

(ii) Authorized personnel rosters shall be maintained for not less than 30 years.

(iii) Medical records shall be maintained for the duration of the employment of each employee plus 20 years, or 30 years, whichever is longer.

(3) In the event that the employer ceases to do business and there is no successor to receive and retain his records for the prescribed period, these records shall be transmitted by registered mail to the Director, and each employee individually notified in writing of this transfer.

(4) Employees or their designated representatives shall be provided access to examine and copy records of required monitoring and measuring.

(5) Former employees shall be provided access to examine and copy required monitoring and measuring records reflecting their own exposures.

(6) Upon written request of any employee, a copy of the medical record of that employee shall be furnished to any physician designated by the employee.

(n) *Reports.* (1) Not later than 1 month after the establishment of a regulated area, the following information shall be reported to the OSHA Area Director. Any changes to such information shall be reported within 15 days.

(i) The address and location of each establishment which has one or more regulated areas; and

(ii) The number of employees in each regulated area during normal operations, including maintenance.

(2) Emergencies, and the facts obtainable at that time, shall be reported within 24 hours to the OSHA Area Director. Upon request of the Area Director, the employer shall submit additional information in writing relevant to the nature and extent of employee exposures and measures taken to prevent future emergencies of similar nature.

(3) Within 10 working days following any monitoring and measuring which discloses that any employee has been exposed, without regard to the use of respirators, in excess of the permissible exposure limit, each such employee shall be notified in writing of the results of the exposure measurement and the steps being taken to reduce the exposure to within the permissible exposure limit.

(o) *Effective dates.* (1) Until April 1, 1975, the provisions currently set forth in § 1910.93q of this Part shall apply.

(2) Effective April 1, 1975, the provisions set forth in § 1910.93q of this Part shall apply.

APPENDIX A—SUPPLEMENTARY MEDICAL INFORMATION

When required tests under paragraph (k)(1) of this section show abnormalities, the tests should be repeated as soon as practicable, preferably within 3 to 4 weeks. If tests remain abnormal, consideration should be given to withdrawal of the employee from contact with vinyl chloride, while a more comprehensive examination is made.

Additional tests which may be useful:

A. For kidney dysfunction: urine examination for albumin, red blood cells, and exfoliative abnormal cells.

B. Pulmonary system: Forced vital capacity, Forced expiratory volume at 1 second, and chest roentgenogram (posterior-anterior, 14 × 17 inches).

C. Additional serum tests: Lactic acid dehydrogenase, lactic acid dehydrogenase isoenzyme, protein determination, and protein electrophoresis.

D. For a more comprehensive examination on repeated abnormal serum tests: Hepatitis B antigen, and liver scanning.

**§ 1910.1018 Inorganic arsenic.**

(a) *Scope and application.* This section applies to all occupational expo-

sures to inorganic arsenic except that this section does not apply to employee exposures in agriculture or resulting from pesticide application, the treatment of wood with preservatives or the utilization of arsenically preserved wood.

(b) *Definitions.* "Action level" means a concentration of inorganic arsenic of 5 micrograms per cubic meter of air (5 $\mu g/m^3$) averaged over any eight (8) hour period.

"Assistant Secretary" means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

"Authorized person" means any person specifically authorized by the employer whose duties require the person to enter a regulated area, or any person entering such an area as a designated representative of employees for the purpose of exercising the right to observe monitoring and measuring procedures under paragraph (e) of this section.

"Director" means the Director, National Institute for Occupational Safety and Health, U.S. Department of Health, Education and Welfare, or designee.

"Inorganic arsenic" means copper aceto- arsenite and all inorganic compounds containing arsenic except arsine, measured as arsenic (As).

(c) *Permissible exposure limit.* The employer shall assure that no employee is exposed to inorganic arsenic at concentrations greater than 10 micrograms per cubic meter of air (10 $\mu g/m^3$), averaged over any 8-hour period.

(d) *Notification of use.* (1) By October 1, 1978 or within 60 days after the introduction of inorganic arsenic into the workplace, every employer who is required to establish a regulated area in his workplaces shall report in writing to the OSHA area office for each such workplace:

(i) The address of each such workplace;

(ii) The approximate number of employees who will be working in regulated areas; and

(iii) A brief summary of the operations creating the exposure and the actions which the employer intends to take to reduce exposures.

(2) Whenever there has been a significant change in the information required by paragraph (d)(1) of this section the employer shall report the changes in writing within 60 days to the OSHA area office.

(e) *Exposure monitoring*—(1) *General.* (i) Determinations of airborne exposure levels shall be made from air samples that are representative of each employee's exposure to inorganic arsenic over an eight (8) hour period.

(ii) For the purposes of this section, employee exposure is that exposure which would occur if the employee were not using a respirator.

(iii) The employer shall collect full shift (for at least 7 continuous hours) personal samples including at least one sample for each shift for each job classification in each work area.

(2) *Initial monitoring.* Each employer who has a workplace or work operation covered by this standard shall monitor each such workplace and work operation to accurately determine the airborne concentration of inorganic arsenic to which employees may be exposed.

(3) *Frequency.* (i) If the initial monitoring reveals employee exposure to be below the action level the measurements need not be repeated except as otherwise provided in paragraph (e)(4) of this section.

(ii) If the initial monitoring, required by this section, or subsequent monitoring reveals employee exposure to be above the permissible exposure limit, the employer shall repeat monitoring at least quarterly.

(iii) If the initial monitoring, required by this section, or subsequent monitoring reveals employee exposure to be above the action level and below the permissible exposure limit the employee shall repeat monitoring at least every six months.

(iv) The employer shall continue monitoring at the required frequency until at least two consecutive measurements, taken at least seven (7) days apart, are below the action level at which time the employer may discontinue monitoring for that employee until such time as any of the events in paragraph (e)(4) of this section occur.

(4) *Additional monitoring.* Whenever there has been a production, process, control or personal change which may result in new or additional exposure to inorganic arsenic, or whenever the employer has any other reason to suspect a change which may result in new or additional exposures to inorganic arsenic, additional monitoring which complies with paragraph (e) of this section shall be conducted.

(5) *Employee notification.* (i) Within five (5) working days after the receipt of monitoring results, the employer shall notify each employee in writing of the results which represent that employee's exposures.

(ii) Whenever the results indicate that the representative employee exposure exceeds the permissible exposure limit, the employer shall include in the written notice a statement that the permissible exposure limit was exceeded and a description of the corrective action taken to reduce exposure to or below the permissible exposure limit.

(6) *Accuracy of measurement.* (i) The employer shall use a method of monitoring and measurement which has an accuracy (with a confidence level of 95 percent) of not less than plus or minus 25 percent for concentrations of inorganic arsenic greater than or equal to 10 $\mu g/m^3$.

(ii) The employer shall use a method of monitoring and measurement which has an accuracy (with confidence level of 95 percent) of not less than plus or minus 35 percent for concentrations of inorganic arsenic greater than 5 $\mu g/m^3$ but less than 10 $\mu g/m^3$.

(f) *Regulated area*—(1) *Establishment.* The employer shall establish regulated areas where worker exposures to inorganic arsenic, without regard to the use of respirators, are in excess of the permissible limit.

(2) *Demarcation.* Regulated areas shall be demarcated and segregated from the rest of the workplace in any manner that minimizes the number of persons who will be exposed to inorganic arsenic.

(3) *Access.* Access to regulated areas shall be limited to authorized persons or to persons otherwise authorized by the Act or regulations issued pursuant thereto to enter such areas.

(4) *Provision of respirators.* All persons entering a regulated area shall be supplied with a respirator, selected in accordance with paragraph (h)(2) of this section.

(5) *Prohibited activities.* The employer shall assure that in regulated areas, food or beverages are not consumed, smoking products, chewing tobacco and gum are not used and cosmetics are not applied, except that these activities may be conducted in the lunchrooms, change rooms and showers required under paragraph (m) of this section. Drinking water may be consumed in the regulated area.

(g) *Methods of compliance*—(1) *Controls.* (i) The employer shall institute at the earliest possible time but not later than December 31, 1979, engineering and work practice controls to reduce exposures to or below the permissible exposure limit, except to the extent that the employer can establish that such controls are not feasible.

(ii) Where engineering and work practice controls are not sufficient to reduce exposures to or below the permissible exposure limit, they shall nonetheless be used to reduce exposures to the lowest levels achievable by these controls and shall be supplemented by the use of respirators in accordance with paragraph (h) of this section and other necessary personal protective equipment. Employee rotation is not required as a control strategy before respiratory protection is instituted.

(2) *Compliance Program.* (i) The employer shall establish and implement a written program to reduce exposures to or below the permissible exposure

limit by means of engineering and work practice controls.

(ii) Written plans for these compliance programs shall include at least the following:

(A) A description of each operation in which inorganic arsenic is emitted; e.g. machinery used, material processed, controls in place, crew size, operating procedures and maintenance practices;

(B) Engineering plans and studies used to determine methods selected for controlling exposure to inorganic arsenic;

(C) A report of the technology considered in meeting the permissible exposure limit;

(D) Monitoring data;

(E) A detailed schedule for implementation of the engineering controls and work practices that cannot be implemented immediately and for the adaption and implementation of any additional engineering and work practices necessary to meet the permissible exposure limit;

(F) Whenever the employer will not achieve the permissible exposure limit with engineering controls and work practices by December 31, 1979, the employer shall include in the compliance plan an analysis of the effectiveness of the various controls, shall install engineering controls and institute work practices on the quickest schedule feasible, and shall include in the compliance plan and implement a program to minimize the discomfort and maximize the effectiveness of respirator use; and

(G) Other relevant information.

(iii) Written plans for such a program shall be submitted upon request to the Assistant Secretary and the Director, and shall be available at the worksite for examination and copying by the Assistant Secretary, Director, any affected employee or authorized employee representatives.

(iv) The plans required by this paragraph shall be revised and updated at least every 6 months to reflect the current status of the program.

(h) *Respiratory protection*—(1) *General.* The employer shall assure that respirators are used where required under this section to reduce employee exposures to below the permissible exposure limit and in emergencies. Respirators shall be used in the following circumstances:

(i) During the time period necessary to install or implement feasible engineering or work practice controls;

(ii) In work operations such as maintenance and repair activities in which the employer establishes that engineering and work practice controls are not feasible;

(iii) In work situations in which engineering controls and supplemental work practice controls are not yet sufficient to reduce exposures to or below the permissible exposure limit; or

(iv) In emergencies.

(2) *Respirator selection.* (i) Where respirators are required under this section the employer shall select, provide at no cost to the employee and assure the use of the appropriate respirator or combination of respirators from Table I below for inorganic arsenic compounds without significant vapor pressure, or Table II below for inorganic arsenic compounds which have significant vapor pressure.

(ii) Where employee exposures exceed the permissible exposure limit for inorganic arsenic and also exceed the relevant limit for particular gasses such as sulfur dioxide, any air purifying respirator supplied to the employee as permitted by this standard must have a combination high efficiency filter with an appropriate gas sorbent. (See footnote in Table 1)

TABLE I—*Respiratory protection for inorganic arsenic particulate except for those with significant vapor pressure*

| Concentration of inorganic arsenic (as As) or condition of use | Required respirator |
|---|---|
| (i) Unknown or greater or lesser than 20,000 $\mu g/m^3$ (20 $mg/m^3$) or firefighting. | (A) Any full facepiece self-contained breathing apparatus operated in positive pressure mode. |
| (ii) Not greater than 20,000 $\mu g/m^3$ (20 $mg/m^3$) | (A) Supplied air respirator with full facepiece, hood, or helmet or suit and operated in positive pressure mode. |
| (iii) Not greater than 10,000 $\mu g/m^3$ (10 $mg/m^3$) | (A) Powered air-purifying respirators in all inlet face coverings with high efficiency filters.[1] (B) Half-mask supplied air respirators operated in positive pressure mode. |
| (iv) Not greater than 500 $\mu g/m^3$ | (A) Full facepiece air-purifying respirator equipped with high-efficiency filter.[1] (B) Any full facepiece supplied air respirator. (C) Any full facepiece self-contained breathing apparatus. |
| (v) Not greater than 100 $\mu g/m^3$ | (A) Half-mask air-purifying respirator equipped with high-efficiency filter.[1] (B) Any half-mask supplied air respirator. |

[1]High-efficiency filter—99.97 pct efficiency against 0.3 micrometer monodisperse diethyl-hexyl phthalate (DOP) particles.

TABLE II—*Respiratory protection for inorganic arsenicals (such as arsenic trichloride[2] and arsenic phosphide) with significant vapor pressure*

| Concentration of inorganic arsenic (as As) or condition of use | Required respirator |
|---|---|
| (i) Unknown or greater or lesser than 20,000 $\mu g/m^3$ (20 $mg/m^3$) or firefighting. | (A) Any full facepiece self-contained breathing apparatus operated in positive pressure mode. |
| (ii) Not greater than 20,000 $\mu g/m^3$ (20 $mg/m^3$) | (A) Supplied air respirator with full facepiece, hood, or helmet or suit and operated in positive pressure mode. |
| (iii) Not greater than 10,000 $\mu g/m^3$ (10 $mg/m^3$) | (A) Half-mask[1] supplied air respirator operated in positive pressure mode. |
| (iv) Not greater than 500 $\mu g/m^3$ | (A) Front or back mounted gas mask equipped with high-efficiency filter[1] and acid gas canister. (B) Any full facepiece supplied air respirator. (C) Any full facepiece self-contained breathing apparatus. |
| (v) Not greater than 100 $\mu g/m^3$ | (A) Half-mask[1] air-purifying respirator equipped with high-efficiency filter[1] and acid gas cartridge. (B) Any half-mask supplied air respirator. |

[1]High efficiency filter—99.97 pct efficiency against 0.3 micrometer monodisperse diethyl-hexyl phthalate (DOP) particles.

[2]Half-mask respirators shall not be used for protection against arsenic trichloride, as it is rapidly absorbed through the skin.

(iii) The employer shall select respirators from among those approved for protection against dust, fume, and mist by the National Institute for Occupational Safety and Health (NIOSH) under the provisions of 30 CFR Part 11.

(3) *Respirator usage.* (i) The employer shall assure that the respirator issued to the employee exhibits minimum facepiece leakage and that the respirator is fitted properly.

(ii) The employer shall perform qualitative fit tests at the time of initial fitting and at least semi-annually thereafter for each employee wearing respirators, where quantitative fit tests are not required.

(iii) Employers with more than 20 employees wearing respirators shall perform a quantitative face fit test at

the time of initial fitting and at least semi-annually thereafter for each employee wearing negative pressure respirators. The test shall be used to select facepieces that provide the required protection as prescribed in Table I or II.

(iv) If an employee has demonstrated difficulty in breathing during the fitting test or during use, he or she shall be examined by a physician trained in pulmonary medicine to determine whether the employee can wear a respirator while performing the required duty.

(4) *Respirator program.* (i) The employer shall institute a respiratory protection program in accordance with 29 CFR 1910.134 (b), (d), (e) and (f).

(ii) The employer shall permit each employee who uses a filter respirator to change the filter elements whenever an increase in breathing resistance is detected and shall maintain an adequate supply of filter elements for this purpose.

(iii) Employees who wear respirators shall be permitted to leave work areas to wash their face and respirator facepiece to prevent skin irritation associated with respirator use.

(5) *Commencement of respirator use.* (i) The employer's obligation to provide respirators commences on August 1, 1978 for employees exposed to over 500 $\mu g/m^3$ of inorganic arsenic, as soon as possible but not later than October 1, 1978 for employees exposed to over 50 $\mu g/m^3$ of inorganic arsenic, and as soon as possible but no later than December 1, 1978 for employees exposed to between 10 and 50 $\mu g/m^3$ of inorganic arsenic.

(ii) Employees with exposures below 50 $\mu g/m^3$ of inorganic arsenic may choose not to wear respirators until December 31, 1979.

(iii) After December 1, 1978 any employee required to wear respirators may choose, and if so chosen the employer must provide, if it will give proper protection, a powered air purifying respirator and in addition if necessary a combination dust and acid gas respirator for times where exposures to gases are over the relevant exposure limits.

(j) *Protective work clothing and equipment*—(1) *Provision and use.* Where the possibility of skin or eye irritation from inorganic arsenic exists, and for all workers working in regulated areas, the employer shall provide at no cost to the employee, and assure that employees use, appropriate and clean protective work clothing and equipment such as, but not limited to:

(i) Coveralls or similar full-body work clothing;

(ii) Gloves, and shoes or coverlets;

(iii) Face shields or vented goggles when necessary to prevent eye irritation, which comply with the requirements of § 1910.133(a)(2)(a)(6); and

(iv) Impervious clothing for employees subject to exposure to arsenic trichloride.

(2) *Cleaning and replacement.* (i) The employer shall provide the protective clothing required in paragraph (j)(1) of this section in a freshly laundered and dry condition at least weekly, and daily if the employee works in areas where exposure are over 100 $\mu g/m^3$ of inorganic arsenic or in areas where more frequent washing is needed to prevent skin irritation.

(ii) The employer shall clean, launder, or dispose of protective clothing required by paragraph (j)(1) of this section.

(iii) The employer shall repair or replace the protective clothing and equipment as needed to maintain their effectiveness.

(iv) The employer shall assure that all protective clothing is removed at the completion of a work shift only in change rooms prescribed in paragraph (m)(1) of this section.

(v) The employer shall assure that contaminated protective clothing which is to be cleaned, laundered, or disposed of, is placed in a closed container in the change-room which prevents dispersion of inorganic arsenic outside the container.

(vi) The employer shall inform in writing any person who cleans or launders clothing required by this section, of the potentially harmful affects including the carcinogenic effects of exposure to inorganic arsenic.

(vii) The employer shall assure that the containers of contaminated protective clothing and equipment in the workplace or which are to be removed from the workplace are labelled as follows:

CAUTION: Clothing contaminated with inorganic arsenic; do not remove dust by blowing or shaking; Dispose of inorganic arsenic contaminated wash water in accordance with applicable local, State or Federal regulations.

(viii) The employer shall prohibit the removal of inorganic arsenic from protective clothing or equipment by blowing or shaking.

(k) *Housekeeping*—(1) *Surfaces.* All surfaces shall be maintained as free as practicable of accumulations of inorganic arsenic.

(2) *Cleaning floors.* Floors and other accessible surfaces contaminated with inorganic arsenic may not be cleaned by the use of compressed air, and shoveling and brushing may be used only where vacuuming or other relevant methods have been tried and found not to be effective.

(3) *Vacuuming.* Where vacuuming methods are selected, the vacuums shall be used and emptied in a manner

to minimize the reentry of inorganic arsenic into the workplace.

(4) *Housekeeping plan.* A written housekeeping and maintenance plan shall be kept which shall list appropriate frequencies for carrying out housekeeping operations, and for cleaning and maintaining dust collection equipment. The plan shall be available for inspection by the Assistant Secretary.

(5) *Maintenance of equipment.* Periodic cleaning of dust collection and ventilation equipment and checks of their effectiveness shall be carried out to maintain the effectiveness of the system and a notation kept of the last check of effectiveness and cleaning or maintenance.

(l) [Reserved]

(m) *Hygiene facilities and practices*—(1) *Change rooms.* The employer shall provide for employees working in regulated areas or subject to the possibility of skin or eye irritation from inorganic arsenic, clean change rooms equipped with storage facilities for street clothes and separate storage facilities for protective clothing and equipment in accordance with 29 CFR 1910.141(e).

(2) *Showers.* (i) The employer shall assure that employees working in regulated areas or subject to the possibility of skin or eye irritation from inorganic arsenic shower at the end of the work shift.

(ii) The employer shall provide shower facilities in accordance with § 1910.141(d)(3).

(3) *Lunchrooms.* (i) The employer shall provide for employees working in regulated areas, lunchroom facilities which have a temperature controlled, positive pressure, filtered air supply, and which are readily accessible to employees working in regulated areas.

(ii) The employer shall assure that employees working in the regulated area or subject to the possibility of skin or eye irritation from exposure to inorganic arsenic wash their hands and face prior to eating.

(4) *Lavatories.* The employer shall provide lavatory facilities which comply with § 1910.141(d) (1) and (2).

(5) *Vacuuming clothes.* The employer shall provide facilities for employees working in areas where exposure, without regard to the use of respirators, exceeds 100 $\mu g/m^3$ to vacuum their protective clothing and clean or change shoes worn in such areas before entering change rooms, lunchrooms or shower rooms required by paragraph (j) of this section and shall assure that such employees use such facilities.

(6) *Avoidance of skin irritation.* The employer shall assure that no employee is exposed to skin or eye contact with arsenic trichloride, or to skin or eye contact with liquid or particulate inorganic arsenic which is likely to cause skin or eye irritation.

(n) *Medical surveillance*—(1) *General*—(i) *Employees covered.* The employer shall institute a medical surveillance program for the following employees:

(A) All employees who are or will be exposed above the action level, without regard to the use of respirators, at least 30 days per year; and

(B) All employees who have been exposed above the action level, without regard to respirator use, for 30 days or more per year for a total of 10 years or more of combined employment with the employer or predecessor employers prior to or after the effective date of this standard. The determination of exposures prior to the effective date of this standard shall be based upon prior exposure records, comparison with the first measurements taken after the effective date of this standard, or comparison with records of exposures in areas with similar processes, extent of engineering controls utilized and materials used by that employer.

(ii) *Examination by physician.* The employer shall assure that all medical examinations and procedures are performed by or under the supervision of a licensed physician, and shall be provided without cost to the employee, without loss of pay and at a reasonable time and place.

(2) *Initial examinations.* By December 1, 1978, for employees initially covered by the medical provisions of this section, or thereafter at the time of initial assignment to an area where the employee is likely to be exposed over the action level at least 30 days per year, the employer shall provide each affected employee an opportunity for a medical examination, including at least the following elements:

(i) A work history and a medical history which shall include a smoking history and the presence and degree of respiratory symptoms such as breathlessness, cough, sputum production and wheezing.

(ii) A medical examination which shall include at least the following:

(A) A 14" by 17" posterior-anterior chest X-ray and International Labor Office UICC/Cincinnati (ILO U/C) rating;

(B) A nasal and skin examination;

(C) A sputum cytology examination; and

(D) Other examinations which the physician believes appropriate because of the employees exposure to inorganic arsenic or because of required respirator use.

(3) *Periodic examinations.* (i) The employer shall provide the examinations specified in paragraphs (n)(2)(i) and (n)(2)(ii) (A), (B), and (D) at least annually for covered employees who

are under 45 years of age with fewer than 10 years of exposure over the action level without regard to respirator use.

(ii) The employer shall provide the examinations specified in paragraphs (n)(2)(i) and (n)(2)(ii) of this section at least semi-annually for other covered employees.

(iii) Whenever a covered employee has not taken the examinations specified in paragraphs (n)(2)(i) and (n)(2)(ii) of this section within six (6) months preceding the termination of employment, the employer shall provide such examinations to the employee upon termination of employment.

(4) *Additional examinations.* If the employee for any reason develops signs or symptoms commonly associated with exposure to inorganic arsenic the employer shall provide an appropriate examination and emergency medical treatment.

(5) *Information provided to the physician.* The employer shall provide the following information to the examining physician:

(i) A copy of this standard and its appendices;

(ii) A description of the affected employee's duties as they relate to the employee's exposure;

(iii) The employee's representative exposure level or anticipated exposure level;

(iv) A description of any personal protective equipment used or to be used; and

(v) Information from previous medical examinations of the affected employee which is not readily available to the examining physician.

(6) *Physician's written opinion.* (i) The employer shall obtain a written opinion from the examining physician which shall include:

(A) The results of the medical examination and tests performed;

(B) The physician's opinion as to whether the employee has any detected medical conditions which would place the employee at increased risk of material impairment of the employee's health from exposure to inorganic arsenic;

(C) Any recommended limitations upon the employee's exposure to inorganic arsenic or upon the use of protective clothing or equipment such as respirators; and

(D) A statement that the employee has been informed by the physician of the results of the medical examination and any medical conditions which require further explanation or treatment.

(ii) The employer shall instruct the physician not to reveal in the written opinion specific findings or diagnoses unrelated to occupational exposure.

(iii) The employer shall provide a copy of the written opinion to the affected employee.

(o) *Employee information and training*—(1) *Training program.* (i) The employer shall institute a training program for all employees who are subject to exposure to inorganic arsenic above the action level without regard to respirator use, or for whom there is the possibility of skin or eye irritation from inorganic arsenic. The employer shall assure that those employees participate in the training program.

(ii) The training program shall be provided by October 1, 1978, for employees covered by this provision, at the time of initial assignment for those subsequently covered by this provision, and shall be repeated at least quarterly for employees who have optional use of respirators and at least annually for other covered employees thereafter; and the employer shall assure that each employee is informed of the following:

(A) The information contained in Appendix A;

(B) The quantity, location, manner of use, storage, sources of exposure, and the specific nature of operations which could result in exposure to inorganic arsenic as well as any necessary protective steps;

(C) The purpose, proper use, and limitation of respirators;

(D) The purpose and a description of the medical surveillance program as required by paragraph (n) of this section;

(E) The engineering controls and work practices associated with the employee's job assignment; and

(F) A review of this standard.

(2) *Access to training materials.* (i) The employer shall make readily available to all affected employees a copy of this standard and its appendices.

(ii) The employer shall provide; upon request, all materials relating to the employee information and training program to the Assistant Secretary and the Director.

(p) *Signs and labels*—(1) *General.* (i) The employer may use labels or signs required by other statutes, regulations, or ordinances in addition to, or in combination with, signs and labels required by this paragraph.

(ii) The employer shall assure that no statement appears on or near any sign or label required by this paragraph which contradicts or detracts from the meaning of the required sign or label.

(2) *Signs.* (i) The employer shall post signs demarcating regulated areas bearing the legend;

DANGER

INORGANIC ARSENIC

CANCER HAZARD

AUTHORIZED PERSONNEL ONLY

NO SMOKING OR EATING

RESPIRATOR REQUIRED

(ii) The employer shall assure that signs required by this paragraph are illuminated and cleaned as necessary so that the legend is readily visible.

(3) *Labels.* The employer shall apply precautionary labels to all shipping and storage containers of inorganic arsenic, and to all products containing inorganic arsenic except when the inorganic arsenic in the product is bound in such a manner so as to make unlikely the possibility of airborne exposure to inorganic arsenic. (Possible examples of products not requiring labels are semiconductors, light emitting diodes and glass). The label shall bear the following legend:

DANGER

CONTAINS INORGANIC ARSENIC

CANCER HAZARD

HARMFUL IF INHALED OR SWALLOWED

USE ONLY WITH ADEQUATE VENTILATION OR RESPIRATORY PROTECTION

(q) *Recordkeeping*—(1) *Exposure monitoring.* (i) The employer shall establish and maintain an accurate record of all monitoring required by paragraph (e) of this section.

(ii) This record shall include:

(A) The date(s), number, duration, location, and results of each of the samples taken, including a description of the sampling procedure used to determine representative employee exposure where applicable;

(B) A description of the sampling and analytical methods used and evidence of their accuracy;

(C) The type of respiratory protective devices worn, if any;

(D) Name, social security number, and job classification of the employees monitored and of all other employees whose exposure the measurement is intended to represent; and

(E) The environmental variables that could affect the measurement of the employee's exposure.

(ii) The employer shall maintain these monitoring records for at least 40 years or for the duration of employment plus 20 years, whichever, is longer.

(2) *Medical surveillance.* (i) The employer shall establish and maintain an accurate record for each employee subject to medical surveillance as required by paragraph (n) of this section.

(ii) This record shall include:

(A) The name, social security number, and description of duties of the employee;

(B) A copy of the physician's written opinions;

(C) Results of any exposure monitoring done for that employee and the representative exposure levels supplied to the physician; and

(D) Any employee medical complaints related to exposure to inorganic arsenic.

(iii) The employer shall in addition keep, or assure that the examining physician keeps, the following medical records;

(A) A copy of the medical examination results including medical and work history required under paragraph (n) of this section;

(B) A description of the laboratory procedures and a copy of any standards or guidelines used to interpret the test results or references to that information;

(C) The initial X-ray;

(D) The X-rays for the most recent 5 years;

(E) Any X-rays with a demonstrated abnormality and all subsequent X-rays;

(F) The initial cytologic examination slide and written description;

(G) The cytologic examination slide and written description for the most recent 5 years; and

(H) Any cytologic examination slides with demonstrated atypia, if such atypia persists for 3 years, and all subsequent slides and written descriptions.

(iv) The employer shall maintain or assure that the physician maintains those medical records for at least 40 years, or for the duration of employment plus 20 years whichever is longer.

(3) *Availability.* (i) The employer shall make available upon request all records required to be maintained by paragraph (m) of this section to the Assistant Secretary and the Director for examination and copying.

(ii) The employer shall make available upon request records of employee exposure monitoring required by paragraph (q)(1) of this section for inspection and copying to affected employees, former employees and their designated representatives.

(iii) The employer shall make available upon request an employee's medical records and exposure records representative of that employee's exposure required to be maintained by paragraph (q) of this section to the affected employee or former employee or to a physician designated by the affected employee or former employee.

(4) *Transfer of records.* (i) Whenever the employer ceases to do business, the successor employer shall receive and retain all records required to be maintained by this section.

(ii) Whenever the employer ceases to do business and there is no successor employer to receive and retain the records required to be maintained by this section for the prescribed period, these records shall be transmitted to the Director.

(iii) At the expiration of the retention period for the records required to be maintained by this section, the employer shall notify the Director at least 3 months prior to the disposal of such records and shall transmit those records to the Director if he requests them within that period.

(r) *Observation of monitoring*—(1) *Employee observation.* The employer shall provide affected employees or their designated representatives an opportunity to observe any monitoring of employee exposure to inorganic arsenic conducted pursuant to paragraph (e) of this section.

(2) *Observation procedures.* (i) Whenever observation of the monitoring of employee exposure to inorganic arsenic requires entry into an area where the use of respirators, protective clothing, or equipment is required, the employer shall provide the observer with and assure the use of such respirators, clothing, and such equipment, and shall require the observer to comply with all other applicable safety and health procedures.

(ii) Without interfering with the monitoring, observers shall be entitled to;

(A) Receive an explanation of the measurement procedures;

(B) Observe all steps related to the monitoring of inorganic arsenic performed at the place of exposure; and

(C) Record the results obtained or receive copies of the results when returned by the laboratory.

(s) *Effective date.* This standard shall become effective August 1, 1978.

(t) *Appendices.* The information contained in the appendices to this section is not intended by itself, to create any additional obligations not otherwise imposed by this standard nor detract from any existing obligation.

(u) *Startup dates*—(1) *General.* The startup dates of requirements of this standard shall be the effective date of this standard unless another startup date is provided for either in other paragraphs of this section or in this paragraph.

(2) *Monitoring.* Initial monitoring shall be commenced on August 1, 1978, and shall be completed by September 15, 1978.

(3) *Regulated areas.* Regulated areas required to be established as a result of initial monitoring shall be set up as soon as possible after the results of that monitoring is known and no later than October 1, 1978.

(4) *Compliance program.* The written program required by paragraph (g)(4) as a result of initial monitoring shall be made available for inspection and copying as soon as possible and no later than December 1, 1978.

(5) *Hygiene and lunchroom facilities.* Construction plans for changerooms, showers, lavatories, and lunchroom facilities shall be completed no later than December 1, 1978, and these facilities shall be constructed and in use no later than July 1, 1979. However, if as part of the compliance plan it is predicted by an independent engineering firm that engineering controls and work practices will reduce exposures below the permissible exposure limit by December 31, 1979, for affected employees, then such facilities need not be completed until 1 year after the engineering controls are completed or December 31, 1980, whichever is earlier, if such controls have not in fact succeeded in reducing exposure to below the permissible exposure limit.

(6) *Summary of startup dates set forth elsewhere in this standard.*

STARTUP DATES

August 1, 1978—Respirator use over 500 $\mu g/m^3$.

AS SOON AS POSSIBLE BUT NO LATER THAN

September 15, 1978—Completion of initial monitoring.

October 1, 1978—Complete establishment of regulated areas. Respirator use for employees exposed above 50 $\mu g/m^3$. Completion of initial training. Notification of use.

December 1, 1978—Respirator use over 10 $\mu g/m^3$. Completion of initial medical. Completion of compliance plan.

July 1, 1979—Completion of lunch rooms and hygiene facilities.

December 31, 1979—Completion of engineering controls.

All other requirements of the standard have as their startup date August 1, 1978.

APPENDIX A—INORGANIC ARSENIC SUBSTANCE INFORMATION SHEET

I. SUBSTANCE IDENTIFICATION

A. *Substance.* Inorganic Arsenic.

B. *Definition.* Copper acetoarsenite, arsenic and all inorganic compounds containing arsenic except arsine, measured as arsenic (As).

C. *Permissible Exposure Limit.* 10 micrograms per cubic meter of air as determined as an average over an 8-hour period. No employee may be exposed to any skin or eye contact with arsenic trichloride or to skin or eye contact likely to cause skin or eye irritation.

D. *Regulated Areas.* Only employees authorized by your employer should enter a regulated area.

II. HEALTH HAZARD DATA

A. *Comments.* The health hazard of inorganic arsenic is high.

B. *Ways in which the chemical affects your body.* Exposure to airborne concentrations of inorganic arsenic may cause lung cancer, and can be a skin irritant. Inorganic arsenic may also affect your body if swal-

lowed. One compound in particular, arsenic trichloride, is especially dangerous because it can be absorbed readily through the skin. Because inorganic arsenic is a poison, you should wash your hands thoroughly prior to eating or smoking.

III. PROTECTIVE CLOTHING AND EQUIPMENT

A. *Respirators.* Respirators will be provided by your employer at no cost to you for routine use if your employer is in the process of implementing engineering and work practice controls or where engineering and work practice controls are not feasible or insufficient. You must wear respirators for non-routine activities or in emergency situations where you are likely to be exposed to levels of inorganic arsenic in excess of the permissible exposure limit. Since how well your respirator fits your face is very important, your employer is required to conduct fit tests to make sure the respirator seals properly when you wear it. These tests are simple and rapid and will be explained to you during training sessions.

B. *Protective clothing.* If you work in a regulated area, your employer is required to provide at no cost to you, and you must wear, appropriate, clean, protective clothing and equipment. The purpose of this equipment is to prevent you from bringing to your home arsenic-contaminated dust and to protect your body from repeated skin contact with inorganic arsenic likely to cause skin irritation. This clothing should include such items as coveralls or similar full-body clothing, gloves, shoes or coverlets, and aprons. Protective equipment should include face shields or vented goggles, where eye irritation may occur.

IV. HYGIENE FACILITIES AND PRACTICES

You must not eat, drink, smoke, chew gum or tobacco, or apply cosmetics in the regulated area, except that drinking water is permitted. If you work in a regulated area your employer is required to provide lunchrooms and other areas for these purposes.

If you work in a regulated area, your employer is required to provide showers, washing facilities, and change rooms. You must wash your face, and hands before eating and must shower at the end of the work shift. Do not take used protective clothing out of change rooms without your employer's permission. Your employer is required to provide for laundering or cleaning of your protective clothing.

V. SIGNS AND LABELS

Your employer is required to post warning signs and labels for your protection. Signs must be posted in regulated areas. The signs must warn that a cancer hazard is present, that only authorized employees may enter the area, and that no smoking or eating is allowed, and that respirators must be worn.

VI. MEDICAL EXAMINATIONS

If your exposure to arsenic is over the Action Level (5 $\mu g/m^3$)—(including all persons working in regulated areas) at least 30 days per year, or you have been exposed to arsenic for more than 10 years over the Action Level, your employer is required to provide you with a medical examination. The examination shall be every 6 months for employees over 45 years old or with more than 10 years exposure over the Action Level and annually for other covered employees. The medical examination must include a medical history; a chest x-ray; skin examination; nasal examination and sputum cytology exam for the early detection of lung cancer. The cytology exams are only included in the initial exam and examinations given after you are either 45 years or older or have 10 or more years employment over the Action Level. The examining physician will provide a written opinion to your employer containing the results of the medical exams. You should also receive a copy of this opinion. The physician must not tell your employer any conditions he detects unrelated to occupational exposure to arsenic but must tell you those conditions.

VII. OBSERVATION OF MONITORING

Your employer is required to monitor your exposure to arsenic and you or your representatives are entitled to observe the monitoring procedure. You are entitled to receive an explanation of the measurement procedure, and to record the results obtained. When the monitoring procedure is taking place in an area where respirators or personal protective clothing and equipment are required to be worn, you must also be provided with and must wear the protective clothing and equipment.

VIII. ACCESS TO RECORDS

You or your representative are entitled to records of your exposure to inorganic arsenic upon request to your employer. Your medical examination records can be furnished to your physician if you request your employer to provide them.

IX. TRAINING AND NOTIFICATION

Additional information on all of these items plus training as to hazards of exposure to inorganic arsenic and the engineering and work practice controls associated with your job will also be provided by your employer. If you are exposed over the permissible exposure limit, your employer must inform you of that fact and the actions he is taking to reduce your exposures.

## APPENDIX B—SUBSTANCE TECHNICAL GUIDELINES

### ARSENIC, ARSENIC TRIOXIDE, ARSENIC TRICHLORIDE (THREE EXAMPLES)

*I. Physical and chemical properties*

A. Arsenic (metal).
1. Formula: As.
2. Appearance: Gray metal.
3. Melting point: Sublimes without melting at 613C.
4. Specific Gravity: (H20=1):5.73.
5. Solubility in water: Insoluble.

B. Arsenic Trioxide.
1. Formula: As203, (As406).
2. Appearance: White powder.
3. Melting point: 315C.
4. Specific Gravity (H20=1):3.74.
5. Solubility in water: 3.7 grams in 100cc of water at 20c.

C. Arsenic Trichloride (liquid).
1. Formula: AsC13.
2. Appearance: Colorless or pale yellow liquid.
3. Melting point: −8.5C.
4. Boiling point: 130.2C.
5. Specific Gravity (H20=1):2.16 at 20C.
6. Vapor Pressure: 10mm Hg at 23.5C.
7. Solubility in Water: Decomposes in water.

*II. Fire, explosion and reactivity data.*

A. Fire: Arsenic, arsenic Trioxide and Arsenic Trichloride are nonflammable.

B. Reactivity:
1. Conditions Contributing to instability: Heat.
2. Incompatibility: Hydrogen gas can react with inorganic arsenic to form the highly toxic gas arsine.

*III. Monitoring and Measurement Procedures*

Samples collected should be full shift (at least 7-hour) samples. Sampling should be done using a personal sampling pump at a flow rate of 2 liters per minute. Samples should be collected on 0.8 micrometer pore size membrane filter (37mm diameter). Volatile arsenicals such as arsenic trichloride can be most easily collected in a midget bubbler filled with 15 ml. of 0.1 N NaOH.

The method of sampling and analysis should have an accuracy of not less than ±25 percent (with a confidence limit of 95 percent) for 10 micrograms per cubic meter of air (10 $\mu g/m^3$) and ±35 percent (with a confidence limit of 95 percent) for concentrations of inorganic arsenic between 5 and 10 $\mu g/m^3$.

## APPENDIX C—MEDICAL SURVEILLANCE GUIDELINES

I. GENERAL

Medical examinations are to be provided for all employees exposed to levels of inorganic arsenic above the action level (5 $\mu g/m^3$) for at least 30 days per year (which would include among others, all employees, who work in regulated areas). Examinations are also to be provided to all employees who have had 10 years or more exposure above the action level for more than 30 days per year while working for the present or predecessor employer though they may no longer be exposed above the level.

An initial medical examination is to be provided to all such employees by December 1, 1978. In addition, an initial medical examination is to be provided to all employees who are first assigned to areas in which worker exposure will probably exceed 5 $\mu g/m^3$ (after the effective date of this standard) at the time of initial assignment. In addition to its immediate diagnostic usefulness, the initial examination will provide a baseline for comparing future test results. The initial examination must include as a minimum the following elements:

(1) A work and medical history, including a smoking history, and presence and degree of respiratory symptoms such as breathlessness, cough, sputum production, and wheezing;

(2) A 14" by 17" posterior-anterior chest X-ray and an International Labor Office UICC/Cincinnati (ILO U/C) rating;

(3) A nasal and skin examination;

(4) A Sputum Cytology examination; and

(5) Other examinations which the physician believes appropriate because of the employee's exposure to inorganic arsenic or because of required respirator use.

Periodic examinations are also to be provided to the employees listed above. The periodic examinations shall be given annually for those covered employees 45 years of age or less with fewer than 10 years employment in areas where employee exposure exceeds the action level (5 $\mu g/m^3$). Periodic examinations need not include sputum cytology and only an updated medical history is required.

Periodic examinations for other covered employees, shall be provided every six (6) months. These examinations shall include all tests required in the initial examination, except that the medical history need only be updated.

The examination contents are minimum requirements. Additional tests such as lateral and oblique X-rays or pulmonary function tests may be useful. For workers exposed to three arsenicals which are associated with lymphatic cancer, copper acetoarsenite, potassium arsenite, or sodium arsenite the examination should also include palpation of superficial lymph nodes and complete blood count.

II. NONCARCINOGENIC EFFECTS

The OSHA standard is based on minimizing risk of exposed workers dying of lung cancer from exposure to inorganic arsenic. It will also minimize skin cancer from such exposures.

The following three sections quoted from "Occupational Diseases: A Guide to Their Recognition", Revised Edition, June 1977, National Institute for Occupational Safety and Health is included to provide information on the nonneoplastic effects of exposure to inorganic arsenic. Such effects should not occur if the OSHA standards are followed.

A. *Local*—Trivalent arsenic compounds are corrosive to the skin. Brief contact has no effect but prolonged contact results in a local hyperemia and later vesicular or pustular eruption. The moist mucous membranes are most sensitive to the irritant action. Conjunctiva, moist and macerated areas of skin, the eyelids, the angles of the ears, nose, mouth, and respiratory mucosa are also vulnerable to the irritant effects. The wrists are common sites of dermatitis, as are the genitalia if personal hygiene is poor. Perforations of the nasal septum may occur. Arsenic trioxide and pentoxide are capable of producing skin sensitization and contact dermatitis. Arsenic is also capable of producing keratoses, especially of the palms and soles.

B. *Systemic*—The acute toxic effects of arsenic are generally seen following ingestion of inorganic arsenical compounds. This rarely occurs in an industrial setting. Symptoms develop within ½ to 4 hours following ingestion and are usually characterized by constriction of the throat followed by dysphagia, epigastric pain, vomiting, and watery diarrhea. Blood may appear in vomitus and stools. If the amount ingested is sufficiently high, shock may develop due to severe fluid loss, and death may ensue in 24 hours. If the acute effects are survived, exfoliative dermatitis and peripheral neuritis may develop.

Cases of acute arsenical poisoning due to inhalation are exceedingly rare in industry. When it does occur, respiratory tract symptoms—cough, chest pain, dyspnea—giddiness, headache, and extreme general weakness precede gastrointestinal symptoms. The acute toxic symptoms of trivalent arsenical poisoning are due to severe inflammation of the mucous membranes and greatly increased permeability of the blood capillaries.

Chronic arsenical poisoning due to ingestion is rare and generally confined to patients taking prescribed medications. However, it can be a concomitant of inhaled inorganic arsenic from swallowed sputum and improper eating habits. Symptoms are weight loss, nausea and diarrhea alternating with constipation, pigmentation and eruption of the skin, loss of hair, and peripheral neuritis. Chronic hepatitis and cirrhosis have been described. Polyneuritis may be the salient feature, but more frequently there are numbness and parasthenias of "glove and stocking" distribution. The skin lesions are usually melanotic and keratotic and may occasionally take the form of an intradermal cancer of the squamous cell type, but without infiltrative properties. Horizontal white lines (striations) on the fingernails and toenails are commonly seen in chronic arsenical poisoning and are considered to be a diagnostic accompaniment of arsenical polyneuritis.

Inhalation of inorganic arsenic compounds is the most common cause of chronic poisoning in the industrial situation. This condition is divided into three phases based on signs and symptoms.

First Phase: The worker complains of weakness, loss of appetite, some nausea, occasional vomiting, a sense of heaviness in the stomach, and some diarrhea.

Second Phase: The worker complains of conjunctivitis, a catarrhal state of the mucous membranes of the nose, larynx, and respiratory passage. Coryza, hoarseness, and mild tracheobronchitis may occur. Perforation of the nasal septum is common, and is probably the most typical lesion of the upper respiratory tract in occupational exposure to arsenical dust. Skin lesions, eczematoid and allergic in type, are common.

Third Phase: The worker complains of symptoms of peripheral neuritis, initially of hands and feet, which is essentially sensory. In more severe cases, motor paralyses occur; the first muscles affected are usually the toe extensors and the peronei. In only the most severe cases will paralysis of flexor muscles of the feet or of the extensor muscles of hands occur.

Liver damage from chronic arsenical poisoning is still debated, and as yet the question is unanswered. In cases of chronic and acute arsenical poisoning, toxic effects to the myocardium have been reported based on EKG changes. These findings, however, are now largely discounted and the EKG changes are ascribed to electrolyte disturbances concomitant with arsenicalism. Inhalation of arsenic trioxide and other inorganic arsenical dusts does not give rise to radiological evidence or pneumoconiosis. Arsenic does have a depressant effect upon the bone marrow, with disturbances of both erythropoiesis and myelopoiesis.

BIBLIOGRAPHY

Dinman, B. D. 1960. Arsenic; chronic human intoxication. J. Occup. Med. 2:137.

Elkins, H. B. 1959. The Chemistry of Industrial Toxicology, 2nd ed. John Wiley and Sons, New York.

Holmquist, L. 1951. Occupational arsenical dermatitis; a study among employees at a copper-ore smelting works including investigations of skin reactions to contact with arsenic compounds. Acta. Derm. Venereol. (Supp. 26) 31:1.

Pinto, S. S., and C. M. McGill. 1953. Arsenic trioxide exposure in industry. Ind. Med. Surg. 22:281.

Pinto, S. S., and K. W. Nelson. 1976. Arsenic toxicology and industrial exposure. Annu. Rev. Pharmacol. Toxicol. 16:95.

Vallee, B. L., D. D. Ulmer, and W. E. C. Wacker. 1960. Arsenic toxicology and biochemistry. AMA Arch. Indust. Health 21:132.

III. SPUTUM CYTOLOGY

Sputum can be collected by aerosol inhalation during the medical exam or by spontaneous early morning cough at home. Sputum is induced by transoral inhalation of an aerosolized solution of eight per cent (8 percent) sodium chloride in water. After inhaling as few as three to five breaths the subject usually yields an adequate sputum. All sputum should be collected directly into sixty percent (60 percent) alcohol.

Scientific evidence suggests that chest X-rays and sputum cytology should be used together as screening tests for lung tests for lung cancer in high risk populations such as workers exposed to inorganic arsenic. The tests are to be performed every six months on workers who are 45 years of age or older or have worked in the regulated area for 10 or more years. Since the tests seem to be complementary, it may be advantageous to alternate the test procedures. For instance, chest X-rays could be obtained in June and December and sputum cytologies could be obtained in March and September. Facilities for providing necessary diagnostic investigation should be readily available as well as chest physicians, surgeons, radiologists, pathologists and immunotherapists to provide any necessary treatment services.

(Pub. L. 91-596; Secs. 4, 6, 8, 84 Stat. 1592, 1593, 1599 (29 U.S.C. 653, 655, 657); Secretary of Labor's Order 8-76 (41 FR 25059); 29 CFR Part 1911).

**§ 1910.1028 Benzene.**

(a) *Scope and application.* (1) This section applies to each place of employment where benzene is produced, reacted, released, packaged, repackaged, stored, transported, handled, or used.

(2) This section does not apply to: (i) The storage, transportation, distribution, dispensing, sale or use as fuel of gasoline, motor fuels, or other fuels subsequent to discharge from bulk terminals; or

(ii) The storage, transportation, distribution or sale of benzene in intact containers sealed in such a manner as to contain benzene vapors or liquid, except for the requirements of paragraph (k) (2), (3), (4), and (5), and paragraph (j) of this section.

(b) *Definitions.* "Action level" means an airborne concentration of benzene of 0.5 ppm, averaged over an 8-hour work day.

"Assistant Secretary" means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

"Authorized person" means any person required by his duties to enter a regulated area and authorized to do so by his employer, by this section or by the Occupational Safety and Health Act of 1970. "Authorized person" includes a representative of employees who is designated to observe monitoring and measuring proce-

dures under paragraph (m) of this section.

"Benzene" ($C_6H_6$) (CAS Registry No. 00071432) means solid, liquefied or gaseous benzene. It includes mixtures of liquids containing benzene and the vapors released by these liquids.

"Bulk terminal" means a facility which is used for the storage and distribution of gasoline, motor fuels or other fuels and which receives its petroleum products by pipeline, barge or marine tanker.

"Director" means the Director of the National Institute for Occupational Safety and Health, U.S. Department of Health, Education, and Welfare, or designee.

"Emergency" means any occurrence such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment which may, or does, result in a massive release of benzene.

"OSHA Area Office" means the office of the Occupational Safety and Health Administration having jurisdiction over the geographic area where the affected workplace is located.

(c) *Permissible exposure limits*—(1) *Inhalation*—(i) *Time-weighted average limit (TWA).* The employer shall assure that no employee is exposed to an airborne concentration of benzene in excess of 1 part benzene per million parts of air (1 ppm) as an 8-hour time-weighted average.

(ii) *Ceiling limit.* The employer shall assure that no employee is exposed to an airborne concentration of benzene in excess of 5 ppm as averaged over any 15 minute period.

(2) *Dermal and eye exposure limit.* The employer shall assure that no employee is exposed to eye contact with liquid benzene; or to skin contact with liquid benzene, unless the employer can establish that the skin contact is an isolated instance.

(d) *Regulated areas.* (1) The employer shall establish, within each place of employment, regulated areas where benzene concentrations are in excess of the permissible airborne exposure limit.

(2) The employer shall limit access to regulated areas to authorized persons.

(3) *Notification of regulated areas.* Within 30 days following the establishment of a regulated area, the employer shall report the following information to the OSHA Area Office:

(i) The address of each establishment which has one or more regulated areas;

(ii) The locations, within the establishment, of each regulated area;

(iii) A brief description of each process or operation which results in employee exposure to benzene in regulated areas; and

(iv) The number of employees engaged in each process or operation within each regulated area which results in exposure to benzene, and an estimate of the frequency and degree of exposure within each regulated area.

(e) *Exposure monitoring and measurements*—(1) *General.* (i) Determinations of airborne exposure levels shall be made from air samples that are representative of each employee's exposure to benzene over an eight (8) hour period.

(ii) For the purposes of this section, employee exposure is that exposure which would occur if the employee were not using a respirator.

(2) *Initial monitoring.* (i) Each employer, who has a place of employment where benzene is produced, reacted, released, packaged, repackaged, stored, transported, handled or used shall monitor each of these workplaces and work operations to accurately determine the airborne concentrations of benzene to which employees may be exposed.

(ii) The initial monitoring required under paragraph (e)(2)(i) of this section shall be conducted and the results obtained within 30 days of the effective date of this section. Where the employer has monitored after January 4, 1977 and the monitoring satisfies the accuracy requirements of paragraph (e)(6) of the section, the employer may rely on such earlier monitoring to satisfy the requirements of paragraph (e)(2)(i) of this section, unless there has been a production, process, personnel or control change which may have resulted in new or additional exposures to benzene or the employer has any other reason to suspect a change which may have resulted in new or additional exposures to benzene; and provided that the employer maintains a record of the monitoring in accordance with paragraph (l)(1) and notifies each employee in accordance with paragraph (e)(5).

(3) *Frequency*—(i) *Measurements below the action level.* If the measurements conducted under paragraph (e)(2)(i) of this section reveal employee exposure to be below the action level, the measurements need not be repeated, except as otherwise provided in paragraph (e)(4) of this section.

(ii) *Measurements at or above the action level.* If the measurements reveal employee exposure to be at or in excess of the action level, but below the permissible exposure limit, the employer shall repeat the monitoring at least quarterly. The employer shall continue these quarterly measurements until at least two consecutive measurements, taken at least seven (7) days apart, are below the action level, and thereafter the employer may discontinue monitoring, except as provided in paragraph (e)(4) of this section.

(iii) *Measurements above the permissible exposure limit.* If the measurements reveal employee exposure to be in excess of the permissible exposure limits, the employer shall repeat the measurements at least monthly. The employer shall continue these monthly measurements until at least two consecutive measurements, taken at least seven (7) days apart, are below the permissible exposure limits, and thereafter the employer shall monitor at least quarterly.

(4) *Additional monitoring.* (i) Whenever there has been a production, process, personnel or control change which may result in new or additional exposure to benzene or whenever the employer has any other reason to suspect a change which may result in new or additional exposures to benzene, the employer shall repeat the monitoring which is required by paragraph (e)(2)(i) of this section.

(ii) Whenever spills, leaks, ruptures or other breakdowns occur, the employer shall repeat the monitoring which is required by paragraph (e)(2)(i) after cleanup of the spill or repair of the leak, rupture or other breakdown.

(5) *Employee notification.* (i) Within 5 working days after the receipt of the measurement results, the employer shall notify each employee in writing of the exposure measurements which represent that employee's exposures.

(ii) Where the results indicate that the employee's exposure exceeds the permissible exposure limits, the notification shall also include the corrective action being taken or to be taken by the employer to reduce exposure to or below the permissible exposure limit.

(6) *Accuracy of measurement.* The employer shall use a method of measurement which has an accuracy, to a confidence level of 95 percent, of not less than plus or minus 25 percent for concentrations of benzene greater than or equal to 1 ppm.

(f) *Methods of compliance*—(1) *Priority of compliance methods.* The employer shall institute engineering and work practice controls to reduce and maintain employee exposures to benzene at or below the permissible exposure limits, except to the extent that the employer establishes that these controls are not feasible. Where feasible engineering and work practice controls are not sufficient to reduce employee exposure to or below the permissible exposure limits, the employer shall nonetheless use them to reduce exposures to the lowest level achievable by these controls, and shall supplement them by the use of respiratory protection.

(2) *Compliance program.* (i) The employer shall establish and implement a

written program to reduce exposures to or below the permissible exposure limits solely by means of engineering and work practice controls required by paragraph (f)(1) of this section.

(ii) The written program shall include a schedule for development and implementation of the engineering and work practice controls. These plans shall be revised at least every six months to reflect the current status of the program.

(iii) Written plans for these compliance programs shall be submitted, upon request, to the Assistant Secretary and the Director, and shall be available at the worksite for examination and copying by the Assistant Secretary, the Director, and the employees or their authorized representatives.

(iv) The employer shall institute and maintain at least the controls described in his most recent written compliance program.

(g) *Respiratory protection*—(1) *General.* Where respiratory protection is required under this section, the employer shall select, provide and assure the use of respirators. Respirators shall be used in the following circumstances:

(i) During the time period necessary to install or implement feasible engineering and work practice controls;

(ii) During maintenance and repair activities in which engineering and work practice controls are not feasible;

(iii) In work situations where feasible engineering and work practice controls are not yet sufficient to reduce exposure to or below the permissible exposure limits; or

(iv) In emergencies.

(2) *Respirator selection.* (i) Where respiratory protection is required under this section, the employer shall select and provide, at no cost to the employee, the appropriate respirator from Table 1 below and shall assure that the employee uses the respirator provided.

(ii) The employer shall select respirators from among those approved by the National Institute for Occupational Safety and Health under the program of 30 CFR Part 11.

(3) *Respirator program.* The employer shall institute a respiratory protection program in accordance with § 1910.134 (b), (d), (e) and (f).

(4) *Respirator use.* (i) Where air purifying respirators (cartridge, canister, or gas mask) are used, the employer shall, except as provided in paragraph (g)(4)(ii) of this section, replace the air-purifying canisters or cartridges prior to the expiration of their service life or the end of shift in which they are first used, whichever occurs first.

TABLE I.—*Respiratory protection for benzene*

| *Airborne concentration of benezene or condition of use* | *Respirator type* |
|---|---|
| (a) Less than or equal to 10 p/m. | (1) Any chemical cartridge respirator with organic vapor cartridge; or<br>(2) Any supplied air respirator. |
| (b) Less than or equal to 50 p/m. | (1) Any chemical cartridge respirator with organic vapor cartridge and full facepiece;<br>(2) Any supplied air respirator with full facepiece;<br>(3) Any organic vapor gas mask; or<br>(4) Any self-contained breathing apparatus with full facepiece. |
| (c) Less than or equal to 1,000 p/m. | (1) Supplied air respirator with half mask in positive pressure mode. |
| (d) Less than or equal to 2,000 p/m. | (1) Supplied air respirator with full facepiece, helmet, or hood, in positive pressure mode. |
| (e) Less than or equal to 10,000 p/m. | (1) Supplied air respirator and auxiliary self-contained facepiece in positive pressure mode; or<br>(2) Open circuit self-contained breathing apparatus with full facepiece in positive pressure mode. |
| (f) Escape | (1) Any organic vapor gas mask; or<br>(2) Any self-contained breathing apparatus with full facepiece. |

(ii) Where a cartridge or canister of an air purifying respirator has an end of service life indicator certified by the National Institute for Occupational Safety and Health for benzene, the employer may permit its use until such time as the indicator shows the end of service life.

(iii) The employer shall assure that the respirator issued to the employee exhibits minimum facepiece leakage and that the respirator is properly fitted

(iv) The employer shall allow each employee who wears a respirator to wash his or her face and respirator facepiece to prevent skin irritation associated with respirator use.

(h) *Protective clothing and equipment.* Where eye or dermal exposure may occur, the employer shall provide, at no cost to the employee, and assure that the employee wears impermeable protective clothing and equipment to protect the area of the body which may come in contact with liquid benzene. Eye and face protection shall meet the requirements of § 1910.133 of this Part.

(i) *Medical Surveillance*—(1) *General.* (i) The employer shall make available a medical surveillance program for employees who are or may be exposed to benzene at or above the action level and employees who are subjected to an emergency.

(ii) The employer shall assure that all medical examinations and procedures are performed by or under the supervision of a licensed physician, and provided without cost to the employee.

(2) *Initial examinations.* (i) Within thirty days of the effective date of this section, or before the time of initial assignment, the employer shall provide each employee who is or may be exposed to benzene at or above the action level with a medical examination, including at least the following elements:

(*a*) A history which includes past work exposure to benzene or any other hematologic toxins; a family history of blood dyscrasias including hematological neoplasms; a history of blood dyscrasias including genetically related hemoglobin alterations, bleeding abnormalities, abnormal function of formed blood elements; a history of renal or liver dysfunction; a history of drugs routinely taken, alcoholic intake and systemic infections; a history of exposure to marrow toxins outside of the current work situation, including volatile cleaning agents and insecticides;

(*b*) Laboratory tests, including a complete blood count with red cell count, white cell count with differential, platelet count, hematocrit, hemoglobin and red cell indices (MCV, MCH, MCHC), serum bilirubin and reticulocyte count; and

(*c*) Additional tests where, in the opinion of the examining physician, alterations in the components of the blood are related to benzene exposure.

(ii) No medical examination is required to satisfy the requirements of paragraph (i)(2)(i) of this section if adequate records show that the employee has been examined in accordance with the procedures of paragraph (i)(2)(i) of this section within the previous six months.

(3) *Information provided to the physician.* The employer shall provide the following information to the examining physician for each examination under this section:

(i) A copy of this regulation and its appendices;

(ii) A description of the affected employee's duties as they relate to the employee's exposure;

(iii) The employee's representative exposure level or anticipated exposure level;

(iv) A description of any personal protective equipment used or to be used; and

(v) Information from previous medical examinations of the affected employee which is not readily available to the examining physican.

(4) *Physician's written opinions.* (i) For each examination under this section, the employer shall obtain and provide the employee with a copy of the examining physician's written opinion containing the following:

(*a*) The results of the medical examination and tests;

(*b*) The physician's opinion concerning whether the employee has any detected medical conditions which would place the employee's health at increased risk of material impairment from exposure to benzene;

(*c*) The physician's recommended limitations upon the employee's exposure to benzene or upon the employee's use of protective clothing or equipment and respirators.

(ii) The written opinion obtained by the employer shall not reveal specific findings or diagnoses unrelated to occupational exposures.

(5) *Periodic examinations.* (i) The employer shall provide each employee covered under paragraph (i)(2) of this section with a medical examination at least semi-annually following the initial examination. These periodic examinations shall include at least the following elements:

(*a*) A brief history regarding any new exposure to potential marrow toxins, changes in drug and alcohol intake and the appearance of physical symptoms relating to blood disorders;

(*b*) A complete blood count with red cell count, white cell count with differential, platelet count, hemoglobin, hematocrit and red cell indices (MCV, MCH, MCHC); and

(*c*) Additional tests where in the opinion of the examining physician, alterations in the components of the blood are related to benzene exposure.

(ii) Where the employee develops signs and symptoms commonly associated with toxic exposure to benzene, the employer shall provide the employee with a medical examination which shall include those elements considered appropriate by the examining physician.

(6) *Emergency situations.* If the employee is exposed to benzene in an emergency situation, the employer shall provide the employee with a urinary phenol test at the end of the employee's shift. The urine specific gravity shall be corrected to 1.024. If the result of the urinary phenol test is below 75 mg phenol/L of urine, no further testing is required. If the result of the urinary phenol test is equal to or greater than 75 mg phenol/L of urine, the employer shall provide the employee with a complete blood count including a red cell count, white cell count with differential, and platelet count as soon as practicable, and shall provide these same counts one month later.

(7) *Special examinations.* (i) Where the results of any tests required by this section reveal that any of the following conditions exist, the employer shall have the test results of the employee evaluated by a hematologist:

(*a*) The red cell count, hemoglobin or platelet count varies more than 15 percent above or below the employee's most recent values;

(*b*) The red cell count is below 4.4 million or above 6.3 million per $mm^3$, (for males), or below 4.2 million or above 5.5 million per $mm^3$ (for females);

(*c*) The hemoglobin is below 14 grams percent or above 18 grams percent (for males) or below 12 grams percent or above 16 grams percent (for females);

(*d*) The white cell count is below 4,200 or above 10,000/$mm^3$;

(*e*) The thrombocyte count is below $140\times10^3$ cells per $mm^3$ or above $440\times10^3$ cells per $mm^3$.

(ii) In addition to the information required to be provided to the physician under paragraph (i)(3) of this section, the employer shall provide the hematologist with the medical record required to be maintained by paragraph (l)(2) of this section.

(iii) The hematologist's evaluation shall include a determination as to the need for additional tests, and the employer shall assure that these tests are provided.

(j) *Employee information and training*—(1) *Training program.* (i) The employer shall institute a training program for all employees assigned to workplaces where benzene is produced, reacted, released, packaged, repackaged, stored, transported, handled or used and shall assure that each employee assigned to these workplaces is informed of the following:

(*a*) The information contained in Appendices A and B of this section;

(*b*) The quantity, location, manner of use, release, or storage of benzene and the specific nature of operations which could result in exposure above the permissible exposure limits as well as necessary protective steps;

(*c*) The purpose, proper use, and limitations of personal protective equipment and clothing required by paragraph (h) of this section and of respiratory devices required by paragraph (g) of this section and § 1910.134 (b), (d), (e), and (f);

(*d*) The purpose and a description of the medical surveillance program required by paragraph (i) of this section and the information contained in Appendix C of this section; and

(*e*) The contents of this standard.

(ii) The training program required under paragraph (j)(1)(i) of this section shall be provided within 90 days of the effective date of this section or at the time of initial assignment to workplaces where benzene is produced, reacted, released, packaged, repackaged, stored, transported, handled or used, and at least annually thereafter.

(2) *Access to training materials.* (i) The employer shall make a copy of this standard and its Appendices readily available to all affected employees.

(ii) The employer shall provide, upon request, all materials relating to the employee information and training program to the Assistant Secretary and the Director.

(k) *Signs and labels.* (1) The employer shall post signs in regulated areas bearing the following legend:

DANGER

BENZENE

CANCER HAZARD

FLAMMABLE—NO SMOKING

AUTHORIZED PERSONNEL ONLY

RESPIRATOR REQUIRED

(2) The employer shall assure that caution labels are affixed to all containers of benzene and of products containing any amount of benzene, except:

(i) Pipelines, and

(ii) Transport vessels or vehicles carrying benzene or benzene products in sealed intact containers.

(3) The employer shall assure that the caution labels remain affixed when the benzene or products containing benzene are sold, distributed or otherwise leave the employer's workplace.

(4) The caution labels required by paragraph (k)(2) of this section shall be readily visible and legible. The labels shall bear the following legend:

CAUTION

CONTAINS BENZENE

CANCER HAZARD

(5) The employer shall assure that no statement which contradicts or detracts from the information required by paragraphs (k)(1) and (k)(4) of this section appears on or near any required sign or label.

(l) *Recordkeeping*—(1) *Exposure measurements.* (i) The employer shall establish and maintain an accurate record of all measurements required by paragraph (e) of this section.

(ii) This record shall include:

(*a*) The dates, number, duration, and results of each of the samples taken, including a description of the procedure used to determine representative employee exposures;

(*b*) A description of the sampling and analytical methods used;

(*c*) Type of respiratory protective devices worn, if any; and

(*d*) Name, social security number, and job classification of the employee

monitored and all other employees whose exposure the measurement is intended to represent.

(iii) The employer shall maintain this record for at least 40 years or the duration of employment plus 20 years, whichever is longer.

(2) *Medical surveillance.* (i) The employer shall establish and maintain an accurate record for each employee subject to medical surveillance required by paragraph (i) of this section.

(ii) This record shall include:

(*a*) The name, and social security number of the employee;

(*b*) A copy of the physicians' written opinions, including results of medical examinations and all tests, opinions and recommendations;

(*c*) The peripheral blood smear slides of the initial test, the most recent test, and any test demonstrating hematological abnormalities related to benzene exposure;

(*d*) Any employee medical complaints related to exposure to benzene;

(*e*) A copy of this standard and its appendices, except that the employer may keep one copy of the standard and its appendices for all employees provided that he references the standard and its appendices in the medical surveillance record of each employee;

(*f*) A copy of the information provided to the physician as required by paragraphs (i)(3)(ii) through (i)(3)(v) of this section; and

(*g*) A copy of the employee's medical and work history related to exposure to benzene or any other hematologic toxins.

(iii) The employer shall maintain this record for at least 40 years or for the duration of employment plus 20 years, whichever is longer.

(3) *Availability.* (i) The employer shall assure that all records required to be maintained by this section shall be made available upon request to the Assistant Secretary and the Director for examination and copying.

(ii) The employer shall assure that employee exposure measurement records as required by this section be made available for examination and copying to affected employees or their designated representatives.

(iii) The employer shall assure that former employees and the former employees' designated representatives have access to such records as will indicate the former employee's own exposure to benzene.

(iv) The employer shall assure that employee medical records required to be maintained by this section be made available upon request for examination and copying to the employee or former employee or to a physician or other individual designated by the affected employee or former employee.

(4) *Transfer of records.* (i) When the employer ceases to do business, the successor employer shall receive and retain all records required to be maintained by paragraph (l) of this section for the prescribed period.

(ii) When the employer ceases to do business and there is no successor employer to receive and retain the records for the prescribed period, the employer shall transmit these records by mail to the Director.

(iii) At the expiration of the retention period for the records required to be maintained under paragraph (l) of this section, the employer shall transmit these records by mail to the Director.

(m) *Observation of monitoring*—(1) *Employee observation.* The employer shall provide affected employees, or their designated representatives, an opportunity to observe any measuring or monitoring of employee exposure to benzene conducted pursuant to paragraph (e) of this section.

(2) *Observation procedures.* (i) When observation of the measuring or monitoring of employee exposure to benzene requires entry into areas where the use of protective clothing and equipment or respirators is required, the employer shall provide the observer with personal protective clothing and equipment or respirators required to be worn by employees working in the area, assure the use of such clothing and equipment or respirators, and require the observer to comply with all other applicable safety and health procedures.

(ii) Without interfering with the measurement, observers shall be entitled to:

(*a*) Receive an explanation of the measurement procedures;

(*b*) Observe all steps related to the measurement of airborne concentrations of benzene performed at the place of exposure; and

(*c*) Record the results obtained.

(n) *Appendices.* The information contained in the appendices is not intended, by itself, to create any additional obligations not otherwise imposed or to detract from any existing obligations.

## Appendix A—Substance Safety Data Sheet, Benzene

### I. SUBSTANCE IDENTIFICATION

A. *Substance.* Benzene.

B. *Permissible Exposure:* Except as to the use as fuels of gasoline, motor fuels and other fuels subsequent to discharge from bulk terminals.

1. *Airborne.* 1 part of benzene vapor per million parts of air (1 ppm); time-weighted average (TWA) for an 8-hour workday for a 40-hour week, with a 15 minute ceiling concentration of 5 ppm.

2. *Dermal.* Eye contact and skin contact with liquid benzene shall be prohibited.

C. *Appearance and odor.* Benzene is a clear, colorless liquid with a pleasant, sweet odor. The odor of benzene does not provide adequate warning of its hazard.

### II. HEALTH HAZARD DATA

A. *Ways in which benzene affects your health.* Benzene can affect your health if you inhale it, or if it comes in contact with your skin or eyes. Benzene is also harmful if you happen to swallow it.

B. *Effects of overexposure.* 1. Short-term (acute) overexposure: If you are overexposed to high concentrations of benzene, well above the levels where its odors are first recognizable, you may feel breathless, irritable, euphoric, or giddy; you may experience irritation in eyes, nose, and respiratory tract. You may develop a headache, feel dizzy, nauseous, or experience unsteadiness in walking. Severe exposures may lead to convulsions.

2. *Long-term (chronic) exposure.* Repeated or prolonged exposure to benzene, even at relatively low concentrations, may result in various blood disorders, ranging from anemia to leukemia, an irreversible, fatal disease. Many blood disorders associated with benzene exposure may occur without physical symptoms.

### III. PROTECTIVE CLOTHING AND EQUIPMENT

A. *Respirators.* Respirators are required for those operations in which engineering controls or work practice controls are not feasible to reduce exposure to the permissible level. If respirators are worn, they must have a National Institute for Occupational Safety and Health (NIOSH) seal of approval, and cartridges or canisters must be replaced before the end of their service life, or the end of the shift, whichever occurs first. If you experience difficulty breathing while wearing a respirator, tell your employer.

B. *Protective Clothing.* You must wear impervious protective clothing (such as boots, gloves, sleeves, aprons, etc.) over any parts of your body that could be exposed to liquid benzene.

C. *Eye and Face Protection.* You must wear splash proof safety goggles if it is possible that benzene may get into your eyes. In addition, you must wear a face shield if your face could be splashed with benzene liquid.

### IV. EMERGENCY AND FIRST AID PROCEDURES

A. *Eye and face exposure.* If benzene is splashed in your eyes, wash it out immediately with large amounts of water. Call a doctor as soon as possible.

B. *Skin exposure.* If benzene is spilled on your clothing or skin, remove the contaminated clothing and wash the exposed skin with large amounts of water and soap immediately. Wash contaminated clothing before you wear it again.

C. *Breathing.* If you or any other person breathes in large amounts of benzene, get the exposed person to fresh air at once. Apply artificial respiration if breathing has stopped. Call for medical assistance or a doctor as soon as possible.

D. *Swallowing.* If benzene has been swallowed and the patient is conscious, do not induce vomiting. Call for medical assistance or a doctor immediately.

### V. MEDICAL REQUIREMENTS

If you are exposed to benzene at a concentration at or above 0.5 ppm on an 8-hour time-weighted average, your employer is required to provide a medical history and laboratory tests within 30 days of the effective date of this standard and semiannually thereafter if you are continually exposed at

or above 0.5 ppm. These tests shall be provided without cost to you. In addition, if you are accidentally exposed to benzene (either by ingestion, inhalation, or skin/eye contact) under conditions known or suspected to be toxic exposure to benzene, your employer is required to make special tests available to you.

VI. OBSERVATION OF MONITORING

Your employer is required to perform measurements that are representative of your exposure to benzene and you or your designated representative are entitled to observe the monitoring procedure. You are entitled to receive an explanation of the measurement procedure, observe the steps taken in the measurement procedure, and to record the results obtained. When the monitoring procedure is taking place in an area where respirators or personal protective clothing and equipment are required to be worn, you or your representative must also be provided with, and must wear the protective clothing and equipment.

VII. ACCESS TO RECORDS

You or your representative are entitled to see the records of measurements of your exposure to benzene upon request to your employer. Your medical examination records can be furnished to your physician or designated representative upon request to your employer.

VIII. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

Benzene liquid is highly flammable. It should be stored in tightly closed containers in a cool, well ventilated area. Benzene vapor may form explosive mixtures in air. All sources of ignition must be controlled. Use nonsparking tools when opening or closing benzene containers. Ground or bond metal benzene containers. Fire extinguishers, where provided, must be readily available. Know where they are located and how to operate them. Smoking is prohibited in areas where benzene is used or stored. Ask your supervisor where benzene is used in your work area and for additional plant safety rules.

## APPENDIX B—SUBSTANCE TECHNICAL GUIDELINES, BENZENE

I. PHYSICAL AND CHEMICAL DATA

A. *Substance identification.*

1. Synonyms: Benzol, benzole, coal naptha, cyclohexatriene, phene, phenyl hydride, pyrobenzol. (Benzin, petroleum benzin, and Benzine do not contain benzene.)

2. Formula: $C_6H_6$ (CAS Registry Number: 000071432)

B. *Physical data.*

1. Boiling Point (760 mm Hg): 80.1C (176F)
2. Specific Gravity (water = 1): 0.879
3. Vapor Density (air = 1): 2.7
4. Melting Point: 5.5C (42F)
5. Vapor Pressure at 20 C (68F): 75 mm Hg
6. Solubility in Water: .06%
7. Evaporation Rate (ether = 1): 2.8
8. Appearance and Odor: Clear, colorless liquid with a distinctive sweet odor.

II. FIRE, EXPLOSION, AND REACTIVITY HAZARD DATA

A. *Fire.*

1. Flash Point (closed cup): −11 C (12F)
2. Autoignition Temperature: 580 C (1076F)
3. Flammable Limits in Air, % by Volume: Lower 1.3%, Upper: 7.5%
4. Extinguishing Media: Carbon dioxide, dry chemical, or foam.
5. Special Fire-Fighting Procedures: Do not use solid stream of water, since stream will scatter and spread fire. Water spray can be used to keep fire exposed containers cool.
6. Unusual fire and explosion hazards: Benzene is a flammable liquid. Its vapors can form explosive mixtures. All ignition sources must be controlled when benzene is used, handled, or stored. Where liquid or vapor may be released, such areas shall be considered as hazardous locations. Benzene vapors are heavier than air; thus the vapors may travel along the ground and be ignited by open flames or sparks at locations remote from the site at which benzene is handled.
7. Benzene is classified as a *1 B flammable liquid* for the purpose of conforming to the requirements of 29 CFR 1910.106. A concentration exceeding *3250 ppm* is considered a potential fire explosion hazard. Locations where benzene may be present in quantities sufficient to produce explosive or ignitable mixtures are considered *Class I Group D* for the purposes of conforming to the requirement of 29 CFR 1910.309.

B. *Reactivity.*

1. Conditions contributing to instability: Heat.
2. Incompatibility: Heat and oxidizing materials.
3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide).

III. SPILL AND LEAK PROCEDURES

A. *Steps to be taken if the material is released or spilled.* As much benzene as possible should be absorbed with suitable materials, such as dry sand or earth. That remaining must be flushed with large amounts of water. Do not flush benzene into a confined space, such as a sewer, because of explosion danger. Remove all ignition sources. Ventilate enclosed places.

B. *Waste disposal method.* Disposal methods must conform to other jurisdictional regulations. If allowed, benzene may be disposed of: (a) Absorbing it in dry sand or earth and disposing in a sanitary land fill; (b) if small quantities, by removing it to a safe location from buildings or other combustible sources, pouring it in dry sand or earth and cautiously igniting it; (c) if large quantities, by atomizing it in a suitable combustion chamber.

IV. MONITORING AND MEASUREMENT PROCEDURES

A. *Normal monitoring program.* Measurements taken from the purpose of determining employee exposure are best taken so that the representative average 8-hour exposure may be determined from a single 8-hour sample or two (2) 4-hour samples. Short-time interval samples (or grab samples) may also be used to determine average exposure level if a minimum of five measurements are taken in a random manner over the 8-hour work shift. Random sampling means that any portion of the work shift has the same chance of being sampled as any other. The arithmetic average of all such random samples taken on one work shift is an estimate of an employee's average level of exposure for that work shift. Air samples should be taken in the employee's breathing zone (air that would nearly represent that inhaled by the employee). Sampling must be performed by gas absorption tubes or alternative methods meeting the requirements of the standard with subsequent chemical analysis, by gas chromatography. Methods meeting the prescribed accuracy and precision and requirements are available in the "NIOSH Manual of Analytical Methods."

V. MISCELLANEOUS PRECAUTIONS

A. High exposures to benzene can occur when transferring the liquid from one container to another. Such operations should be well ventilated and good work practices must be established to avoid spills.

B. Use non-sparking tools to open benzene containers which are effectively grounded and bonded prior to opening and pouring.

C. Employers must advise employees of all plant areas and operations where exposure to benzene could occur. Common operations in which high exposures to benzene may be encountered are: the primary production and utilization of benzene, and transfer of benzene.

## APPENDIX C—MEDICAL SURVEILLANCE GUIDELINES FOR BENZENE

I. ROUTE OF ENTRY

Inhalation; possible skin absorption.

II. TOXICOLOGY

Benzene is primarily an inhalation hazard. Systemic absorption may cause depression of the hematopoietic system and leukemia. Inhalation of high concentrations can affect the central nervous system function. Aspiration of small amounts of liquid benzene immediately causes pulmonary edema and hemorrhage of pulmonary tissue. The extent of absorption through the skin is unknown. However, absorption may be accelerated in the case of injured skin, and benzene may be more readily absorbed if it is present in a mixture or as a contaminant in solvents which are readily absorbed. Defatting action of benzene may produce primary irritation upon repeated or prolonged contact with the skin. High concentrations are irritating to the mucous membranes of the eyes, nose, and respiratory tract.

III. SIGNS AND SYMPTOMS

It is not clear to what extent benzene is absorbed through the skin, however, direct contact may cause erythema or blistering. Repeated or prolonged contact may result in drying, scaling dermatitis, or precipitate development of secondary skin infections. Local effects of benzene vapor or liquid on the eye are slight. Only at very high concentrations is there any smarting sensation in the eye. Inhalation of high concentrations of benzene may have an initial stimulatory effect on the central nervous system characterized by exhilaration, nervous excitation, and/or giddiness, followed by a period of depression, drowsiness, fatigue, or vertigo. There may be sensation of tightness in the chest accompanied by breathlessness and ultimately the victim may lose consciousness. Convulsions and tremors occur frequently, and death may follow from respiratory paralysis or circulatory collapse in a few minutes to several hours following severe exposures.

The insidious effect on the blood-forming system of prolonged exposure to small

quantities of benzene vapor is of extreme importance. The hematopoietic system is the chief target for benzene's toxic effects which are manifested by alterations in the levels of formed elements in the peripheral blood. These effects have been noted to occur at concentrations of benzene which may not cause irritation of mucous membranes, or any unpleasant sensory effects. Early signs and symptoms of benzene morbidity are varied and often not overtly apparent and not specific for benzene exposure. Subjective complaints of headache, dizziness, and loss of appetite may precede or follow clinical symptomology. Bleeding from the nose, gums, or mucous membranes and the development of purpuric spots may occur as the condition progresses. Rapid pulse and low blood pressure in addition to a physical appearance of anemia may accompany a subjective complaint of shortness of breath. Clinical evidence of leukopenia, anemia, and thrombocytopenia, singly or in combination, have been frequently reported.

Bone marrow may appear normal, aplastic, or hyperplastic and may not in all situations correlate with peripheral blood forming tissues. There are great variations in the susceptibility to benzene morbidity which prohibits the identification of "typical" blood picture. The onset of effects of prolonged benzene exposure may be significantly delayed after the actual exposure has ceased.

#### IV. TREATMENT OF ACUTE TOXIC EFFECTS

Remove from exposure immediately, give oxygen or artificial resuscitation if indicated. Flush eyes and wash contaminated skin. Symptoms of non-specific nervous disturbances may persist following severe exposures. Recovery from mild exposures is usually rapid and complete.

#### V. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

##### A. GENERAL

The principal effects of benzene exposure forming the basis for this regulation are alterations of the hematopoietic system as reflected by changes in the peripheral blood and leukemia. Consequently, the medical surveillance protocol is designed to observe on a regular basis, blood indices for early signs of these effects.

Tests must be performed frequently enough to discover individuals who may be unusually sensitive and likely to develop marrow abnormalities, to monitor those who experience accidental overexposure and to provide early detection of delayed evidence of toxicity.

All workers who are or will be exposed to 0.5 parts per million (ppm) or greater benzene as an eight-hour time-weighted average are to be given the opportunity for a medical examination. Initial examinations are to be provided within 30 days of the effective date of this standard or at the time of initial assignment and interval examinations semiannually thereafter. There are special provisions for medical tests in the event of hematolgic abnormalities or for emergency situations.

##### F. HEMATOLOGY GUIDELINES

The following information excerpted from the analysis of Dr. Jandl, Chief of Hematology, Harvard School of Medicine, may be useful to physicians in conducting the medical surveillance program.

"A minimum battery of tests is to be performed by strictly standardized methods in the circumstances described above.

1. Red cell, white cell, and platelet counts must be performed using an automated (Coulter) counter. The normal range for the red cell count is approximately 4.4 to 6.0 million cells/mm$^3$, the values for women being about 0.4 million cells lower than for men. A decline from a normal to a subnormal value, or a rise to a supra-normal value, are indicative of potential toxicity, particularly should there be a decline. The normal total white blood count is approximately 6,200 plus or minus 2,000/mm$^3$. For cigarette smokers and white count will be higher, the upper range of "normal" being approximately 1,000 cells higher than 8,200. Either a decline from normal to subnormal or a rise from normal to supra-normal, should be regarded as a potential indication of benzene toxicity. The normal platelet count is 250,000 with a range of 140,000 to (at most) 400,000/mm$^3$. A decline to below 140,000 or a rise to above 400,000 should be regarded as possible evidence of benzene toxicity.

The reticulocyte count is performed by technical assistants using a cover-slip smear (see below). In my opinion, the preferred technique for this purpose is the so-called "dry-method" employing brilliant cresyl blue (BCB) for staining the filaments of reticulum within red cell, and counter-staining with Wright's stain. The extreme range of normal for reticulocytes is 0.4 to 1.5 percent of the red cells, the usual range being 0.5 to 1.2 percent of the red cells, but the typical value is in the range of 0.8 to 1.0 percent. There is an advantage of using the BCB reticulocyte staining technique (followed by counter-staining with Wright's stain) in that visible evidence (i.e., the stained, mounted reticulocyte smears) may be stored, and if kept filed in the dark may later be retrieved for reexamination and comparisons. A decline in reticulocytes to levels of less than 0.4 percent is to be regarded as possible evidence (unless another specific cause is found) of benzene toxicity requiring accelerated surveillance. An increase in reticulocyte levels to above 1.5 percent may also be consistent with (but is not as characteristic of) benzene toxicity.

2. The single most important routine surveillance test is an expert technician's careful examination of the peripheral blood smear. As with the reticulocyte count, the smear should be with fresh uncoagulated blood obtained from a needle tip following venipuncture or from a drop of earlobe blood (capillary blood). If necessary, the smear may under certain limited conditions be made from a blood sample anticoagulated with EDTA (but never with oxalate or heparin). When the smear is to be prepared from a specimen of venous blood which has been collected by a commercial Vacutainer® type tube containing neutral EDTA, the smear should be made as soon as possible after the venesection. A delay of up to 12 hours is permissible between the drawing of the blood specimen into EDTA and the preparation of the smear if the blood is stored at refrigerator (not freezing) temperature. As with the reticulocyte preparations, the smear should be made on cover slips only. Under no circumstances should peripheral blood (or bone marrow aspirate) intended for examination be smeared on microscope slides, a technique which produces artifacts in blood cells and distorts the white cell differential count by severely maldistributing them. Dry blood smears should be stained with Wright's stain which should be filtered at least weekly to remove precipated dye (saturated completely by methylene blue-eosinate derivates).

3. The minimum mandatory observations to be made from the smear and a discussion of their significance now follows. The observations are four:

a. The differential white blood cell count.

b. Description of abnormalities in the appearance of red cells.

c. Description of any abnormalities in the platelets.

d. A careful search must be made by the technician throughout the better areas of every blood smear for immature white cells such as band forms (in more than normal proportion), any number of metamyelocytes, myelocytes. Any nucleated or multinucleated red blood cells should be reported. Very large "giant" platelets of fragments of megakaryocytes must be recognized. Should only a single one of these abnormalities be found, it should be reported.

An increase in the proportion of band forms among the neutrophilic granulocytes is an abnormality deserving special mention for it represents a very early change which should be considered as an early warning of benzene toxicity in the absence of other causative factors (most commonly infection). Likewise, the appearance of metamyelocytes in the absence of other probable cause is to be considered a possible indication of benzene-induced injury.

An upward trend in the number of basophils, which normally do not exceed about 2.0 percent of the total white cells, is to be regarded as possible evidence of benzene toxicity. A rise in the eosinophil count is less specific but also may be suspicious of toxicity if it rises above 6.0 percent of the total white count.

The normal range of monocytes is from 2.0 to 8.0 percent of the total white count with an average of about 5.0 percent. About 20 percent of individuals reported to have mild but persisting abnormalities caused by exposure to benzene show a persisting monocytosis which is sometimes striking. The findings of a monocyte count which persists at more than 10 to 12 percent of the normal white cell count (when the total count is normal) or persistence of an absolute monocyte count in excess 800/mm$^3$ should be regarded as a possible sign of benzene-induced injury.

A less frequent but more serious indication of benzene-induced injury to the bone marrow is the findings in the peripheral blood of the so-called "pseudo" (or acquired) Pelger-Huet anomaly. In this anomaly many, or sometimes the majority, of the neutrophilic granulocytes possess two round nuclear segments—less often one or three round segments—rather than three normally elongated segments. When this anomaly is not hereditary, it is often but not invariably predictive of subsequent leukemia. However, only about two percent of patients who ultimately develop acute myelogenous leukemia show the acquired Pelger-Huet anomaly.

An uncommon but ominous sign, one which cannot be detected from the smear, but can be suspected easily by a "sucrose water test" or peripheral blood, is transient paroxysmal nocturnalhemoglobinuria

(PNH), which may first occur insidiously during a period of established aplastic anemia and maybe followed within one to a few years by the appearance of rapidly fatal acute myelogenous leukemia. Clinical detection of PHH, which occurs in perhaps only one or two percent of those destined to have acute myelogenous leukemia, may be difficult; if the presumptive "sucrose water test" for it is positive, the technician may perform the somewhat more definitive Ham test, also known as the acid-serum hemolysis test.

e. Individuals documented to have developed acute myelogenous leukemia years after initial exposure to benzene, have (see above) progressed through preliminary phases of hematologic abnormality. In many instances pancytopenia (i.e., a lowering in the counts of all circulating blood cells of bone marrow origin—but not to the extent implied by the term "aplastic anemia") preceded leukemia for many years. Seldom does relative scarcity of a single type blood cell (or of platelets) represent a harbinger of imminent acute leukemia. However, the finding of two or more cytopenias, or of pancytopenia, must be regarded as highly suspicious of more advanced although still reversible, benzene toxicity. When "pancytopenia" develops and becomes associated with the apearance of immature cells (myelocytes, myeloblasts, erythroblasts, etc.), with abnormal cells (pseudo Pelger-Huet anomaly, atypical nuclear heterochromatin, etc.), or with inappropriate elevations of monocytes, basophils, or eosinophils, the findings must be regarded as evidence of benzene overexposure unless proved other-wise. These and other aggregates of alterations are frequently termed "preleukemia," a term whose meaning is good when used retrospectively, but less appropriate when used prospectively where it has only inferential value. Many severely aplastic patients manifested the ominous finding of 5-10 percent myeloblasts in the marrow, occasional myeloblasts and myelocytes in the blood and 20-30% monocytes; these represented the beginning of recovery rather than the early stage of overt AML. Thus, a considerable proportion of "preleukemias" in benzene poisioning fail to progress to leukemia. Indeed, some have been observed to revert to normal after withdrawal of the afflicted person from toxic exposure. Nonetheless, the chance that "preleukemic" will evolve to leukemia is considerable: at least 20 to 40 percent of persons (only a few of whom were benzene-exposed) with these blood changes develop acute myelogenous leukemia. Certain tests may substantiate the person's prospects for progression or regression. One such test would be an examination of patient's bone marrow. But the decision to perform a bone marrow aspiration or needle biopsy is one that should be made by the hematologist. The findings to be sought there would be: hypoplasia or aplasia; an excess of immature forms; vacuolation in erythroblasts and myelocytes—a phenomenon induced by many toxins apart from benzene, including chloramphenicol and alcohol; and by infections.

The findings of basophilic stippling in circulating red blood cells (usually found in 1 to 5% of red cell during marrow injury), and detection in the bone marrow of what are termed "ringed sideroblasts" must be taken seriously, as they have been noted in recent years to be frequent premonitory signs of subsequent acute leukemia.

In several recent reports dealing with relatively few patients, peroxidase-staining of circulating or marrow neutrophil granules, employing benzidine dihydrochloride, has revealed as a "preleukemic" finding the disappearance of, or diminution in, perosidase in a sizable proportion of the granulocytes. Granulocyte granules are normally strongly peroxidase positive. A steady decline in leukocyte alkaline phosphatase is also suggestive of early acute leukemia. Exposure to benzene commonly causes an early rise in serum iron, often but not always associated with a fall in the reticulocyte count. Thus serial measurements of serum iron levels provide a means of determining whether or not there is a trend representing sustained suppress of erythropoiesis.

Measurement of serum iron, determination of peroxidase and of alkaline phosphatase activity in peripheral granulocytes can be performed by technical assistants.

**§ 1910.1029 Coke oven emissions.**

(a) *Scope and application.* This section applies to the control of employee exposure to coke oven emissions, except that this section shall not apply to working conditions with regard to which other Federal agencies exercise statutory authority to prescribe or enforce standards affecting occupational safety and health.

(b) *Definitions.* For the purpose of this section:

"Authorized person" means any person specifically authorized by the employer whose duties require the person to enter a regulated area, or any person entering such an area as a designated representative of employees for the purpose of exercising the opportunity to observe monitoring and measuring procedures under paragraph (n) of this section.

"Beehive oven" means a coke oven in which the products of carbonization other than coke are not recovered, but are released into the ambient air.

"Coke oven" means a retort in which coke is produced by the destructive distillation or carbonization of coal.

"Coke oven battery" means a structure containing a number of slot-type coke ovens.

"Coke oven emissions" means the benzene-soluble fraction of total particulate matter present during the destructive distillation or carbonization of coal for the production of coke.

"Director" means the Director, National Institute for Occupational Safety and Health, U.S. Department of Health, Education, and Welfare, or his or her designee.

"Emergency" means any occurence such as, but not limited to, equipment failure which is likely to, or does, result in any massive release of coke oven emissions.

"Existing coke oven battery" means a battery in operation or under construction on January 20, 1977, and which is not a rehabilitated coke oven battery.

"Green push" means coke which when removed from the oven results in emissions due to the presence of unvolatilized coal.

"Pipeline charging" means any apparatus used to introduce coal into an oven which uses a pipe or duct permanently mounted onto an oven and through which coal is charged.

"Rehabilitated coke oven battery" means a battery which is rebuilt, overhauled, renovated, or restored such as from the pad up, after January 20, 1977.

"Secretary" means the Secretary of Labor, U.S. Department of Labor, or his or her designee.

"Stage charging" means a procedure by which a predetermined volume of coal in each larry car hopper is introduced into an oven such that no more than two hoppers are discharging simultaneously.

"Sequential charging" means a procedure, usually automatically timed, by which a predetermined volume of coal in each larry car hopper is introduced into an oven such that no more than two hoppers commence or finish discharging simultaneously although, at some point, all hoppers are discharging simultaneously.

(c) *Permissible exposure limit.* The employer shall assure that no employee in the regulated area is exposed to coke oven emissions at concentrations greater than 150 micrograms per cubic meter of air (150 $\mu g/m^3$), averaged over any 8-hour period.

(d) *Regulated areas.* (1) The employer shall establish regulated areas and shall limit access to them to authorized persons.

(2) The employer shall establish the following as regulated areas:

(i) The coke oven battery including topside and its machinery, pushside and its machinery, coke side and its machinery, and the battery ends; the wharf; and the screening station;

(ii) The beehive oven and its machinery.

(e) *Exposure monitoring and measurement*—(1) *Monitoring program.* (i) Each employer who has a place of employment where coke oven emissions are present shall monitor employees employed in the regulated area to measure their exposure to coke oven emissions.

(ii) The employer shall obtain measurements which are representative of each employee's exposure to coke oven emissions over an eight-hour period. All measurements shall determine exposure without regard to the use of respiratory protection.

(iii) The employer shall collect full-shift (for at least seven continuous hours) personal samples, including at least one sample during each shift for

each battery and each job classification within the regulated areas including at least the following job classifications:

(*a*) Lidman;
(*b*) Tar chaser;
(*c*) Larry car operator;
(*d*) Luterman;
(*e*) Machine operator, coke side;
(*f*) Benchman, coke side;
(*g*) Benchman, pusher side;
(*h*) Heater;
(*i*) Quenching car operator;
(*j*) Pusher machine operator;
(*k*) Screening station operator;
(*l*) Wharfman;
(*m*) Oven patcher;
(*n*) Oven repairman;
(*o*) Spellman; and
(*p*) Maintenance personnel.

(iv) The employer shall repeat the monitoring and measurements required by this paragraph (e)(1) at least every three months.

(2) *Redetermination.* Whenever there has been a production, process, or control change which may result in new or additional exposure to coke oven emissions, or whenever the employer has any other reason to suspect an increase in employee exposure, the employer shall repeat the monitoring and measurements required by paragraph (e)(1) of this section for those employees affected by such change or increase.

(3) *Employee notification.* (i) The employer shall notify each employee in writing of the exposure measurements which represent that employe's exposure within five working days after the receipt of the results of measurements required by paragraphs (e)(1) and (e)(2) of this section.

(ii) Whenever such results indicate that the representative employee exposure exceeds the permissible exposure limit, the employer shall, in such notification, inform each employee of that fact and of the corrective action being taken to reduce exposure to or below the permissible exposure limit.

(4) *Accuracy of measurement.* The employer shall use a method of monitoring and measurement which has an accuracy (with a confidence level of 95%) of not less than plus or minus 35% for concentrations of coke oven emissions greater than or equal to 150 $\mu g/m^3$.

(f) *Methods of compliance.* The employer shall control employee exposure to coke oven emissions by the use of engineering controls, work practices and respiratory protection as follows:

(1) *Priority of compliance methods—*
(i) *Existing coke oven batteries.* (*a*) The employer shall institute the engineering and work practice controls listed in paragraphs (f)(2), (f)(3) and (f)(4) of this section in existing coke oven batteries at the earliest possible time, but not later than January 20, 1980, except to the extent that the employer can establish that such controls are not feasible. In determining the earliest possible time for institution of engineering and work practice controls, the requirement, effective August 27, 1971, to implement feasible administrative or engineering controls to reduce exposures to coal tar pitch volatiles, shall be considered. Wherever the engineering and work practice controls which can be instituted are not sufficient to reduce employee exposures to or below the permissible exposure limit, the employer shall nonetheless use them to reduce exposures to the lowest level achievable by these controls and shall supplement them by the use of respiratory protection which complies with the requirements of paragraph (g) of this section.

(*b*) The engineering and work practice controls required under paragraphs (f)(2), (f)(3) and (f)(4) of this section are minimum requirements generally applicable to all existing coke oven batteries. If, after implementing all controls required by paragraphs (f)(2), (f)(3) and (f)(4) of this section, or after January 20, 1980, whichever is sooner, employee exposures still exceed the permissible exposure limit, employers shall research, develop and implement any other engineering and work practice controls necessary to reduce exposure to or below the permissible exposure limit except to the extent that the employer can establish that such controls are not feasible. Wherever the engineering and work practice controls which can be instituted are not sufficient to reduce employee exposures to or below the permissible exposure limit, the employer shall nonetheless use them to reduce exposures to the lowest level achievable by these controls and shall supplement them by the use of respiratory protection which complies with the requirements of paragraph (g) of this section.

(ii) *New or rehabilitated coke oven batteries.* (*a*) The employer shall institute the best available engineering and work practice controls on all new or rehabilitated coke oven batteries to reduce and maintain employee exposures at or below the permissible exposure limit, except to the extent that the employer can establish that such controls are not feasible. Wherever the engineering and work practice controls which can be instituted are not sufficient to reduce employee exposures to or below the permissible exposure limit, the employer shall nonetheless use them to reduce exposures to the lowest level achievable by these controls and shall supplement them by the use of respiratory protection which complies with the requirements of paragraph (g) of this section.

(*b*) If after implementing all the engineering and work practice controls required by paragraph (f)(1)(ii)(*a*) of this section, employee exposures still exceed the permissible exposure limit, the employer shall research, develop and implement any other engineering and work practice controls necessary to reduce exposure to or below the permissible exposure limit except to the extent that the employer can establish that such controls are not feasible. Wherever the engineering and work practice controls which can be instituted are not sufficient to reduce employee exposures to or below the permissible exposure limit the employer shall nonetheless use them to reduce exposures to the lowest level achievable by these controls and shall supplement them by the use of respiratory protection which complies with the requirements of paragraph (g) of this section.

(iii) *Beehive ovens.* (*a*) The employer shall institute engineering and work practice controls on all beehive ovens at the earliest possible time to reduce and maintain employee exposures at or below the permissible exposure limit, except to the extent that the employer can establish that such controls are not feasible. In determining the earliest possible time for institution of engineering and work practice controls, the requirement, effective August 27, 1971, to implement feasible administrative or engineering controls to reduce exposures to coal tar pitch volatiles, shall be considered. Wherever the engineering and work practice controls which can be instituted are not sufficient to reduce employee exposures to or below the permissible exposure limit, the employer shall nonetheless use them to reduce exposures to the lowest level achievable by these controls and shall supplement them by the use of respiratory protection which complies with the requirements of paragraph (g) of this section.

(*b*) If, after implementing all engineering and work practice controls required by paragraph (f)(1)(iii)(*a*) of this section, employee exposures still exceed the permissible exposure limit, the employer shall research, develop, and implement any other engineering and work practice controls necessary to reduce exposures to or below the permissible exposure limit except to the extent that the employer can establish that such controls are not feasible. Wherever the engineering and work practice controls which can be instituted are not sufficient to reduce employee exposures to or below the permissible exposure limit, the employer shall nonetheless use them to reduce exposures to the lowest level achievable by these controls and shall supplement them by the use of respiratory protection which complies with

the requirements of paragraph (g) of this section.

(2) *Engineering controls*—(i) *Charging.* The employer shall equip and operate existing coke oven batteries with all of the following engineering controls to control coke oven emissions during charging operations:

(*a*) One of the following methods of charging:

(*1*) Stage charging as described in paragraph (f)(3)(i)(*b*) of this section; or

(*2*) Sequential charging as described in paragraph (f)(3)(i)(*b*) of this section except that paragraph (f)(3)(i)(*b*)(*3*)(*iv*) of this section does not apply to sequential charging; or

(*3*) Pipeline charging or other forms of enclosed charging in accordance with paragraph (f)(2)(i) of this section, except that paragraphs (f)(2)(i)(*b*), (*d*), (*e*), (*f*) and (*h*) of this section do not apply;

(*b*) Drafting from two or more points in the oven being charged, through the use of double collector mains, or a fixed or moveable jumper pipe system to another oven, to effectively remove the gases from the oven to the collector mains;

(*c*) Aspiration systems designed and operated to provide sufficient negative pressure and flow volume to effectively move the gases evolved during charging into the collector mains, including sufficient steam pressure, and steam jets of sufficient diameter;

(*d*) Mechanical volumetric controls on each larry car hopper to provide the proper amount of coal to be charged through each charging hole so that the tunnel head will be sufficient to permit the gases to move from the oven into the collector mains;

(*e*) Devices to facilitate the rapid and continuous flow of coal into the oven being charged, such as stainless steel liners, coal vibrators or pneumatic shells;

(*f*) Individually operated larry car drop sleeves and slide gates designed and maintained so that the gases are effectively removed from the oven into the collector mains;

(*g*) Mechanized gooseneck and standpipe cleaners;

(*h*) Air seals on the pusher machine leveler bars to control air infiltration during charging; and

(*i*) Roof carbon cutters or a compressed air system or both on the pusher machine rams to remove roof carbon.

(ii) *Coking.* The employer shall equip and operate existing coke oven batteries with all of the following engineering controls to control coke oven emissions during coking operations:

(*a*) A pressure control system on each battery to obtain uniform collector main pressure;

(*b*) Ready access to door repair facilities capable of prompt and efficient repair of doors, door sealing edges and all door parts;

(*c*) An adequate number of spare doors available for replacement purposes;

(*d*) Chuck door gaskets to control chuck door emissions until such door is repaired, or replaced; and

(*e*) Heat shields on door machines.

(3) *Work practice controls.* (i) *Charging.* The employer shall operate existing coke oven batteries with all of the following work practices to control coke oven emissions during the charging operation:

(*a*) Establishment and implementation of a detailed, written inspection and cleaning procedure for each battery consisting of at least the following elements:

(*1*) Prompt and effective repair or replacement of all engineering controls;

(*2*) Inspection and cleaning of goosenecks and standpipes prior to each charge to a specified minimum diameter sufficient to effectively move the evolved gases from the oven to the collector mains;

(*3*) Inspection for roof carbon buildup prior to each charge and removal of roof carbon as necessary to provide an adequate gas channel so that the gases are effectively moved from the oven into the collector mains;

(*4*) Inspection of the steam aspiration system prior to each charge so that sufficient pressure and volume is maintained to effectively move the gases from the oven to the collector mains;

(*5*) Inspection of steam nozzles and liquor sprays prior to each charge and cleaning as necessary so that the steam nozzles and liquor sprays are clean;

(*6*) Inspection of standpipe caps prior to each charge and cleaning and luting or both as necessary so that the gases are effectively moved from the oven to the collector mains; and

(*7*) Inspection of charging holes and lids for cracks, warpage and other defects prior to each charge and removal of carbon to prevent emissions, and application of luting material to standpipe and charging hole lids where necessary to obtain a proper seal.

(*b*) Establishment and implementation of a detailed written charging procedure, designed and operated to eliminate emissions during charging for each battery, consisting of at least the following elements:

(*1*) Larry car hoppers filled with coal to a predetermined level in accordance with the mechanical volumetric controls required under paragraph (f)(2)(i)(*d*) of this section so as to maintain a sufficient gas passage in the oven to be charged;

(*2*) The larry car aligned over the oven to be charged, so that the drop sleeves fit tightly over the charging holes; and

(*3*) The oven charged in accordance with the following sequence of requirements:

(*i*) The aspiration system turned on;

(*ii*) Coal charged through the outermost hoppers, either individually or together depending on the capacity of the aspiration system to collect the gases involved;

(*iii*) The charging holes used under paragraph (f)(3)(i)(*b*)(*3*)(*ii*) of this section relidded or otherwise sealed off to prevent leakage of coke oven emissions;

(*iv*) If four hoppers are used, the third hopper discharged and relidded or otherwise sealed off to prevent leakage of coke oven emissions;

(*v*) The final hopper discharged until the gas channel at the top of the oven is blocked and then the chuck door opened and the coal leveled;

(*vi*) When the coal from the final hopper is discharged and the leveling operation complete, the charging hole relidded or otherwise sealed off to prevent leakage of coke oven emissions; and

(*vii*) The aspiration system turned off only after the charging holes have been closed.

(*c*) Establishment and implementation of a detailed written charging procedure, designed and operated to eliminate emissions during charging of each pipeline or enclosed charged battery.

(ii) *Coking.* The employer shall operate existing coke oven batteries pursuant to a detailed written procedure established and implemented for the control of coke oven emissions during coking, consisting of at least the following elements:

(*a*) Checking oven back pressure controls to maintain uniform pressure conditions in the collecting main;

(*b*) Repair, replacement and adjustment of oven doors and chuck doors and replacement of door jambs so as to provide a continuous metal-to-metal fit;

(*c*) Cleaning of oven doors, chuck doors and door jambs each coking cycle so as to provide an effective seal;

(*d*) An inspection system and corrective action program to control door emissions to the maximum extent possible; and

(*e*) Luting of doors that are sealed by luting each coking cycle and reluting, replacing or adjusting as necessary to control leakage.

(iii) *Pushing.* The employer shall operate existing coke oven batteries with the following work practices to control coke oven emissions during pushing operations:

(a) Coke and coal spillage quenched as soon as practicable and not shoveled into a heated oven; and

(b) A detailed written procedure for each battery established and implemented for the control of emissions during pushing consisting of the following elements:

(1) Dampering off the ovens and removal of charging hole lids to effectively control coke oven emissions during the push;

(2) Heating of the coal charge uniformly for a sufficient period so as to obtain proper coking including preventing green pushes;

(3) Prevention of green pushes to the maximum extent possible;

(4) Inspection, adjustment and correction of heating flue temperatures and defective flues at least weekly and after any green push, so as to prevent green pushes;

(5) Cleaning of heating flues and related equipment to prevent green pushes, at least weekly and after any green push.

(iv) *Maintenance and repair.* The employer shall operate existing coke oven batteries pursuant to a detailed written procedure of maintenance and repair established and implemented for the effective control of coke oven emissions consisting of the following elements:

(a) Regular inspection of all controls, including goosenecks, standpipes, standpipe caps, charging hold lids and castings, jumper pipes and air seals for cracks, misalignment or other defects and prompt implementation of the necessary repairs as soon as possible;

(b) Maintaining the regulated area in a neat, orderly condition free of coal and coke spillage and debris;

(c) Regular inspection of the damper system, aspiration system and collector main for cracks or leakage, and prompt implementation of the necessary repairs;

(d) Regular inspection of the heating system and prompt implementation of the necessary repairs;

(e) Prevention of miscellaneous fugitive topside emissions;

(f) Regular inspection and patching of oven brickwork;

(g) Maintenance of battery equipment and controls in good working order;

(h) Maintenance and repair of coke oven doors, chuck doors, door jambs and seals; and

(i) Repairs instituted and completed as soon as possible, including temporary repair measures instituted and completed where necessary, including but not limited to:

(1) Prevention of miscellaneous fugitive topside emissions; and

(2) Chuck door gaskets, which shall be installed prior to the start of the next coking cycle.

(4) *Filtered air.* (i) The employer shall provide positive-pressure, temperature controlled filtered air for larry car, pusher machine, door machine, and quench car cabs.

(ii) The employer shall provide standby pulpits on the battery topside, at the wharf, and at the screening station, equipped with positive-pressure, temperature controlled filtered air.

(5) *Emergencies.* Whenever an emergency occurs, the next coking cycle may not begin until the cause of the emergency is determined and corrected, unless the employer can establish that it is necessary to initiate the next coking cycle in order to determine the cause of the emergency.

(6) *Compliance program.* (i) Each employer shall establish and implement a written program to reduce exposures solely by means of the engineering and work practice controls required in paragraph (f) of this section.

(ii) The written program shall include at least the following:

(a) A description of each coke oven operation by battery, including work force and operating crew, coking time, operating procedures and maintenance practices;

(b) Engineering plans and other studies used to determine the controls for the coke battery;

(c) A report of the technology considered in meeting the permissible exposure limit;

(d) Monitoring data obtained in accordance with paragraph (e) of this section;

(e) A detailed schedule for the implementation of the engineering and work practice controls specified in paragraph (f) of this section; and

(f) Other relevant information.

(iii) If, after implementing all controls required by paragraphs (f)(2)–(f)(4) of this section, or after January 20, 1980, whichever is sooner, or after completion of a new or rehabilitated battery the permissible exposure limit is still exceeded, the employer shall develop a detailed written program and schedule for the development and implementation of any additional engineering controls and work practices necessary to reduce exposure to or below the permissible exposure limit.

(iv) Written plans for such programs shall be submitted, upon request, to the Secretary and the Director, and shall be available at the worksite for examination and copying by the Secretary, the Director, and the authorized employee representative. The plans required under paragraph (f)(6) of this section shall be revised and updated at least every six months to reflect the current status of the program.

(7) *Training in compliance procedures.* The employer shall incorporate all written procedures and schedules required under this paragraph (f) in the information and training program required under paragraph (k) of this section and, where appropriate, post in the regulated area.

(g) *Respiratory protection*—(1) *General.* (i) Where respiratory protection is required under this section, the employer shall provide and assure the use of respirators which comply with the requirements of this paragraph (g). Compliance with the permissible exposure limit may not be achieved by the use of respirators except:

(a) During the time period necessary to install or implement feasible engineering and work practice controls; or

(b) In work operations such as maintenance and repair activity in which engineering and work practice controls are technologically not feasible; or

(c) In work situations where feasible engineering and work practice controls are not yet sufficient to reduce exposure to or below the permissible exposure limit; or

(d) *In emergencies.*

(ii) Notwithstanding any other requirement of this section, until January 20, 1978, the wearing of respirators shall be at the discretion of each employee where the employee is not in the vicinity of visible emissions.

(2) *Selection.* (i) Where respirators are required under this section, the employer shall select, provide and assure the use of the appropriate respirator or combination of respirators from Table I below.

TABLE I

RESPIRATORY PROTECTION FOR COKE OVEN EMISSIONS

| Airborne concentration of coke oven emissions | Required respirator |
|---|---|
| (a) Any concentration ..... | (1) A Type C supplied air respirator operated in pressure demand or other positive pressure or continuous flow mode; or<br>(2) A powered air-purifying particulate filter respirator for dust, and mist; or<br>(3) A powered air-purifying particulate filter respirator or combination chemical cartridge and particulate filter respirator for coke oven emissions. |
| (b) Concentrations not greater than 1500 μg/m³. | (1) Any particulate filter respirator for dust and mist, except single-use respirator; or<br>(2) Any particulate filter respirator or combination chemical cartridge and particulate filter respirator for coke oven emissions; or |

TABLE I—Continued

RESPIRATORY PROTECTION FOR COKE OVEN EMISSIONS

| Airborne concentration of coke oven emissions | Required respirator |
|---|---|
| | (3) Any respirator listed in paragraph (g)(2)(i)(a) of this section. |

(ii) Not later than January 20, 1978, whenever respirators are required by this section for concentrations not greater than 1500 $\mu g/m^3$, the employer shall provide, at the option of each affected employee, either a particulate filter respirator as provided in paragraph (g)(2)(i)(b) of this section, or a powered air-purifying respirator as provided in paragraph (g)(2)(i)(a) of this section.

(iii) The employer shall select respirators from among those approved for protection against dust and mist by the National Institute for Occupational Safety and Health (NIOSH) under the provisions of 30 CFR Part II, except that not later than January 20, 1979, the employer shall select respirators from among those approved by NIOSH for protection against coke oven emissions.

(3) *Respirator program.* The employer shall institute a respiratory protection program in accordance with § 1910.134 of this part.

(4) *Respirator usage.* (i) The employer shall assure that the respirator issued to the employee exhibits minimum facepiece leakage and that the respirator is fitted properly. The employer shall perform quantitative fit tests annually for each employee who uses a non-powered, particulate filter respirator.

(ii) The employer shall allow each employee who uses a filter respirator to change the filter elements whenever an increase in breathing resistance is detected and shall maintain an adequate supply of filter elements for this purpose.

(iii) The employer shall allow employees who wear respirators to wash their face and respirator facepiece to prevent skin irritation associated with respirator use.

(h) *Protective clothing and equipment*—(1) *Provision and use.* The employer shall provide and assure the use of appropriate protective clothing and equipment, such as but not limited to:

(i) Flame resistant jacket and pants;

(ii) Flame resistant gloves;

(iii) Face shields or vented goggles which comply with § 1910.133(a)(2) of this part;

(iv) Insulation from hot surfaces for footwear;

(v) Safety shoes which comply with § 1910.136 of this part; and

(vi) Protective helmets which comply with § 1910.135 of this part.

(2) *Cleaning and replacement.* (i) The employer shall provide the protective clothing required by paragraphs (h)(1) (i) and (ii) of this section in a clean and dry condition at least weekly.

(ii) The employer shall clean, launder, or dispose of protective clothing required by paragraphs (h)(1) (i) and (ii) of this section.

(iii) The employer shall repair or replace the protective clothing and equipment as needed to maintain their effectiveness.

(iv) The employer shall assure that all protective clothing is removed at the completion of a work shift only in change rooms prescribed in paragraph (i)(1) of this section.

(v) The employer shall assure that contaminated protective clothing which is to be cleaned, laundered, or disposed of, is placed in a closable container in the change room.

(vi) The employer shall inform any person who cleans or launders protective clothing required by this section, of the potentially harmful effects of exposure to coke oven emissions.

(i) *Hygiene facilities and practices*—(1) *Change rooms.* The employer shall provide clean change rooms equipped with storage facilities for street clothes and separate storage facilities for protective clothing and equipment whenever employees are required to wear protective clothing and equipment in accordance with paragraph (h)(1) of this section.

(2) *Showers.* (i) The employer shall assure that employees working in the regulated area shower at the end of the work shift.

(ii) The employer shall provide shower facilities in accordance with § 1910.141(d)(3) of this Part.

(3) *Lunchrooms.* The employer shall provide lunchroom facilities which have a temperature controlled, positive pressure, filtered air supply, and which are readily accessible to employees working in the regulated area.

(4) *Lavatories.* (i) The employer shall assure that employees working in the regulated area wash their hands and face prior to eating.

(ii) The employer shall provide lavatory facilities in accordance with § 1910.141(d) (1) and (2) of this Part.

(5) *Prohibition of activities in the regulated area.* (i) The employer shall assure that in the regulated area, food or beverages are not present or consumed, smoking products are not present or used, and cosmetics are not applied, except that these activities may be conducted in the lunchrooms, change rooms and showers required under paragraphs (i)(1)–(i)(3) of this section.

(ii) Drinking water may be consumed in the regulated area.

(j) *Medical surveillance*—(1) *General requirements.* (i) Each employer shall institute a medical surveillance program for all employees who are employed in a regulated area at least 30 days per year.

(ii) This program shall provide each employee covered under paragraph (j)(1)(i) of this section with an opportunity for medical examinations in accordance with this paragraph (j).

(iii) The employer shall inform any employee who refuses any required medical examination of the possible health consequences of such refusal and shall obtain a signed statement from the employee indicating that the employee understands the risk involved in the refusal to be examined.

(iv) The employer shall assure that all medical examinations and procedures are performed by or under the supervision of a licensed physician, and are provided without cost to the employee.

(2) *Initial examinations.* At the time of initial assignment to a regulated area or upon the institution of the medical surveillance program, the employer shall provide a medical examination for employees covered under paragraph (j)(1)(i) of this section including at least the following elements:

(i) A work history and medical history which shall include smoking history and the presence and degree of respiratory symptoms, such as breathlessness, cough, sputum production, and wheezing;

(ii) A 14" x 17" posterior-anterior chest x-ray and International Labour Office UICC/Cincinnati (ILO U/C) rating;

(iii) Pulmonary function tests including forced vital capacity (FVC) and forced expiratory volume at one second (FEV 1.0) with recording of type of equipment used;

(iv) Weight;

(v) A skin examination;

(vi) Urinalysis for sugar, albumin, and hematuria;

(vii) A sputum cytology examination; and

(viii) A urinary cytology examination.

(3) *Periodic examinations.* (i) The employer shall provide the examinations specified in paragraphs (j)(2) (i)–(vi) of this section at least annually for employees covered under paragraph (j)(1)(i) of this section.

(ii) The employer shall provide the examinations specified in paragraphs (j)(2) (i)–(viii) of this section at least semi-annually for employees 45 years of age or older or with five (5) or more years employment in the regulated area.

(iii) Whenever an employee who is 45 years of age or older or with five (5) or more years employment in the regulated area transfers or is transferred from employment in a regulated area, the employer shall continue to provide the examinations specified in paragraphs (j)(2) (i)–(viii) of this section semi-annually, as long as that employee is employed by the same employer or a successor employer.

(iv) Whenever an employee has not taken the examinations specified in paragraphs (j)(3) (i)–(iii) of this section with the six (6) months preceding the termination of employment the employer shall provide such examinations to the employee upon termination of employment.

(4) *Information provided to the physician.* The employer shall provide the following information to the examining physician:

(i) A copy of this regulation and its Appendixes;

(ii) A description of the affected employee's duties as they relate to the employee's exposure;

(iii) The employee's exposure level or estimated exposure level;

(iv) A description of any personal protective equipment used or to be used; and

(v) Information from previous medical examinations of the affected employee which is not readily available to the examining physician.

(5) *Physician's written opinion.* (i) The employer shall obtain a written opinion from the examining physician which shall include:

(*a*) The results of the medical examinations;

(*b*) The physician's opinion as to whether the employee has any detected medical conditions which would place the employee at increased risk of material impairment of the employee's health from exposure to coke oven emissions;

(*c*) Any recommended limitations upon the employee's exposure to coke oven emissions or upon the use of protective clothing or equipment such as respirators; and

(*d*) A statement that the employee has been informed by the physician of the results of the medical examination and any medical conditions which require further explanation or treatment.

(ii) The employer shall instruct the physician not to reveal in the written opinion specific findings or diagnoses unrelated to occupational exposure.

(iii) The employer shall provide a copy of the written opinion to the affected employee.

(k) *Employee information and training*—(1) *Training program.* (i) The employer shall institute a training program for employees who are employed in the regulated area and shall assure their participation.

(ii) The training program shall be provided as of January 27, 1977 for employees who are employed in the regulated area at that time or at the time of initial assignment to a regulated area.

(iii) The training program shall be provided at least annually for all employees who are employed in the regulated area, except that training regarding the occupational safety and health hazards associated with exposure to coke oven emissions and the purpose, proper use, and limitations of respiratory protective devices shall be provided at least quarterly until January 20, 1978.

(iv) The training program shall include informing each employee of:

(*a*) The information contained in the substance information sheet for coke oven emissions (Appendix A);

(*b*) The purpose, proper use, and limitations of respiratory protective devices required in accordance with paragraph (g) of this section;

(*c*) The purpose for and a description of the medical surveillance program required by paragraph (j) of this section including information on the occupational safety and health hazards associated with exposure to coke oven emissions;

(*d*) A review of all written procedures and schedules required under paragraph (f) of this section; and

(*e*) A review of this standard.

(2) *Access to training materials.* (i) The employer shall make a copy of this standard and its appendixes readily available to all employees who are employed in the regulated area.

(ii) The employer shall provide upon request all materials relating to the employee information and training program to the Secretary and the Director.

(l) *Precautionary signs and labels*—(1) *General.* (i) The employer may use labels or signs required by other statutes, regulations or ordinances in addition to, or in combination with, signs and labels required by this paragraph.

(ii) The employer shall assure that no statement appears on or near any sign required by this paragraph which contradicts or detracts from the effects of the required sign.

(iii) The employer shall assure that signs required by this paragraph are illuminated and cleaned as necessary so that the legend is readily visible.

(2) *Signs.* (i) The employer shall post signs in the regulated area bearing the legends:

DANGER

CANCER HAZARD

AUTHORIZED PERSONNEL ONLY

NO SMOKING OR EATING

(ii) In addition, not later than January 20, 1978, the employer shall post signs in the areas where the permissible exposure limit is exceeded bearing the legend:

DANGER

RESPIRATOR REQUIRED

(3) *Labels.* The employer shall apply precautionary labels to all containers of protective clothing contaminated with coke oven emissions bearing the legend:

CAUTION

CLOTHING CONTAMINATED WITH COKE EMISSIONS

DO NOT REMOVE DUST BY BLOWING OR SHAKING

(m) *Recordkeeping*—(1) *Exposure measurements.* The employer shall establish and maintain an accurate record of all measurements taken to monitor employee exposure to coke oven emissions required in paragraph (e) of this section.

(i) This record shall include:

(*a*) Name, social security number, and job classification of the employees monitored;

(*b*) The date(s), number, duration and results of each of the samples taken, including a description of the sampling procedure used to determine representative employee exposure where applicable;

(*c*) The type of respiratory protective devices worn, if any;

(*d*) A description of the sampling and analytical methods used and evidence of their accuracy; and

(*e*) The environmental variables that could affect the measurement of employee exposure.

(ii) The employer shall maintain this record for at least 40 years or for the duration of employment plus 20 years, whichever is longer.

(2) *Medical surveillance.* The employer shall establish and maintain an accurate record for each employee subject to medical surveillance as required by paragraph (j) of this section.

(i) The record shall include:

(*a*) The name, social security number, and description of duties of the employee;

(*b*) A copy of the physician's written opinion;

(*c*) The signed statement of any refusal to take a medical examination under paragraph (j)(1)(ii) of this section; and

(*d*) Any employee medical complaints related to exposure to coke oven emissions.

(ii) The employer shall keep, or assure that the examining physician keeps, the following medical records:

(*a*) A copy of the medical examination results including medical and work history required under paragraph (j)(2) of this section;

(*b*) A description of the laboratory procedures used and a copy of any standards or guidelines used to interpret the test results;

(*c*) The initial x-ray;

(*d*) The x-rays for the most recent five (5) years;

(*e*) Any x-ray with a demonstrated abnormality and all subsequent x-rays;

(*f*) The initial cytologic examination slide and written description;

(*g*) The cytologic examination slide and written description for the most recent 10 years; and

(*h*) Any cytologic examination slides with demonstrated atypia, if such atypia persists for 3 years, and all subsequent slides and written descriptions.

(iii) The employer shall maintain medical records required under paragraph (m)(2) of this section for at least 40 years, or for the duration of employment plus 20 years, whichever is longer.

(3) *Availability.* (i) The employer shall make available upon request all records required to be maintained by paragraph (m) of this section to the Secretary and the Director for examination and copying.

(ii) The employer shall make available upon request records of employee exposure measurements required by paragraph (m)(1) of this section for inspection and copying to affected employees and their designated representatives.

(iii) The employer shall make available upon request employee medical records required to be maintained by paragraph (m)(2) of this section to a physician designated by the affected employee or former employee.

(iv) The employer shall make available upon request records of employee exposure measurements required by paragraph (m)(1) of this section for inspection and copying to former employees and their designated representatives which indicate the former employees own exposures.

(4) *Transfer of records.* (i) Whenever the employer ceases to do business, the successor employer shall receive and retain all records required to be maintained by paragraph (m) of this section.

(ii) Whenever the employer ceases to do business and there is no successor employer to receive and retain the records for the prescribed period, these records shall be transmitted by registered mail to the Director.

(iii) At the expiration of the retention period for the records required to be maintained under paragraphs (m)(1) and (m)(2) of this section, the employer shall transmit these records by registered mail to the Director or shall continue to retain such records.

(n) *Observation of monitoring*—(1) *Employee observation.* The employer shall provide affected employees or their representatives an opportunity to observe any measuring or monitoring of employee exposure to coke oven emissions conducted pursuant to paragraph (e) of this section.

(2) *Observation procedures.* (i) Whenever observation of the measuring or monitoring of employee exposure to coke oven emissions requires entry into an area where the use of protective clothing or equipment is required, the employer shall provide the observer with and assure the use of such equipment and shall require the observer to comply with all other applicable safety and health procedures.

(ii) Without interfering with the measurement, observers shall be entitled to:

(*a*) An explanation of the measurement procedures;

(*b*) Observe all steps related to the measurement of coke oven emissions performed at the place of exposure; and

(*c*) Record the results obtained.

(o) *Effective date.* This standard shall become effective January 20, 1977.

(p) *Appendixes.* The information contained in the appendixes to this section is not intended, by itself, to create any additional obligations not otherwise imposed or to detract from any existing obligation.

## Appendix A—Coke Oven Emissions Substance Information Sheet

### I. SUBSTANCE IDENTIFICATION

A. *Substance:* Coke Oven Emissions

B. *Definition:* The benzene-soluble fraction of total particulate matter present during the destructive distillation or carbonization of coal for the production of coke.

C. *Permissible Exposure Limit:* 150 micrograms per cubic meter of air determined as an average over an 8-hour period.

D. *Regulated areas:* Only employees authorized by your employer should enter a regulated area. The employer is required to designate the following areas as regulated areas: the coke oven battery, including topside and its machinery, pushside and its machinery, cokeside and its machinery, and the battery ends; the screening station; and the wharf; and the beehive ovens and their machinery.

### II. HEALTH HAZARD DATA

Exposure to coke oven emissions is a cause of lung cancer, and kidney cancer, in humans. Although there have not been an excess number of skin cancer cases in humans, repeated skin contact with coke oven emissions should be avoided.

### III. PROTECTIVE CLOTHING AND EQUIPMENT

A. *Respirators:* Respirators will be provided by your employer for routine use if your employer is in the process of implementing engineering and work practice controls or where engineering and work practice controls are not feasible or insufficient to reduce exposure to or below the PEL. You must wear respirators for non-routine activities or in emergency situations where you are likely to be exposed to levels of coke oven emissions in excess of the permissible exposure limit. Until January 20, 1978, the routine wearing of respirators is voluntary. Until that date, if you choose not to wear a respirator you do not have to do so. You must still have your respirator with you and you must still wear it if you are near visible emissions. Since how well your respirator fits your face is very important, your employer is required to conduct fit tests to make sure the respirator seals properly when you wear it. These tests are simple and rapid and will be explained to you during your training sessions.

B. *Protective clothing:* Your employer is required to provide, and you must wear, appropriate, clean, protective clothing and equipment to protect your body from repeated skin contact with coke oven emissions and from the heat generated during the coking process. This clothing should include such items as jacket and pants and flame resistant gloves. Protective equipment should include face shield or vented goggles, protective helmets and safety shoes, insulated from hot surfaces where appropriate.

### IV. HYGIENE FACILITIES AND PRACTICES

You must not eat, drink, smoke, chew gum or tobacco, or apply cosmetics in the regulated area, except that drinking water is permitted. Your employer is required to provide lunchrooms and other areas for these purposes.

Your employer is required to provide showers, washing facilities, and change rooms. If you work in a regulated area, you must wash your face, and hands before eating. You must shower at the end of the work shift. Do not take used protective clothing out of the change rooms without your employer's permission. Your employer is required to provide for laundering or cleaning of your protective clothing.

### V. SIGNS AND LABELS

Your employer is required to post warning signs and labels for your protection. Signs must be posted in regulated areas. The signs must warn that a cancer hazard is present, that only authorized employees may enter the area, and that no smoking or eating is allowed. In regulated areas where coke oven emissions are above the permissible exposure limit, the signs should also warn that respirators must be worn.

### VI. MEDICAL EXAMINATIONS

If you work in a regulated area at least 30 days per year, your employer is required to provide you with a medical examination every year. The medical examination must include a medical history, a chest x-ray; pulmonary function test; weight comparison; skin examination; a urinalysis and a urine and sputum cytology exam for the early detection of urinary or lung cancer. The cytol-

ogy exams are only included in the intial exam until you are either 45 years or older or have 5 or more years employment in the regulated areas when the medical exams including these tests are to be given every six months. The examining physician will provide a written opinion to your employer containing the results of the medical exams. You should also receive a copy of this opinion.

VII. OBSERVATION OF MONITORING

Your employer is required to monitor your exposure to coke oven emissions and you are entitled to observe the monitoring procedure. You are entitled to receive an explanation of the measurement procedure, observe the steps taken in the measurement procedure, and to record the results obtained. When the monitoring procedure is taking place in an area where respirators or personal protective clothing and equipment are required to be worn, you must also be provided with and must wear the protective clothing and equipment.

VIII. ACCESS TO RECORDS

You or your representative are entitled to records of your exposure to coke oven emissions upon request to your employer. Your medical examination records can be furnished to your physician upon request to your employer.

IX. TRAINING AND EDUCATION

Additional information on all of these items plus training as to hazards of coke oven emissions and the engineering and work practice controls associated with your job will also be provided by your employer.

APPENDIX B—INDUSTRIAL HYGIENE AND MEDICAL SURVEILLANCE GUIDELINES

I. INDUSTRIAL HYGIENE GUIDELINES

A. *Sampling* (Benzene-Soluble Fraction Total Particulate Matter).

Samples collected should be full shift (at least 7-hour) samples. Sampling should be done using a personal sampling pump with pulsation damper at a flow rate of 2 liters per minute. Samples should be collected on 0.8 micrometer pore size silver membrane filters (37 mm diameter) preceded by Gelman glass fiber type A-E filters encased in three-piece plastic (polystyrene) field monitor cassettes. The cassette face cap should be on and the plug removed. The rotameter should be checked every hour to ensure that proper flow rates are maintained.

A minimum of three full-shift samples should be collected for each job classification on each battery, at least one from each shift. If disparate results are obtained for particular job classification, sampling should be repeated. It is advisable to sample each shift on more than one day to account for environmental variables (wind, precipitation, etc.) which may affect sampling. Differences in exposures among different work shifts may indicate a need to improve work practices on a particular shift. Sampling results from different shifts for each job classification should not be averaged. Multiple samples from the same shift on each battery may be used to calculate an average exposure for a particular job classification.

B. *Analysis.*

1. All extraction glassware is cleaned with dichromic acid cleaning solution, rinsed with tap water, then dionized water, acetone, and allowed to dry completely. The glassware is rinsed with nanograde benzene before use. The Teflon cups are cleaned with benzene then with acetone.

2. Pre-weigh the 2 ml Teflon cups to one hundredth of a milligram (0.01 mg) on a autobalance AD 2 Tare weight of the cups is about 50 mg.

3. Place the silver membrane filter and glass fiber filter into a 15 ml test tube.

4. Extract with 5 ml of benzene for five minutes in an ultrasonic cleaner.

5. Filter the extract in 15 ml medium glass fritted funnels.

6. Rinse test tube and filters with two 1.5 ml aliquots of benzene and filter through the fritted glass funnel.

7. Collect the extract and two rinses in a 10 ml Kontes graduated evaporative concentrator.

8. Evaporate down to 1 ml while rinsing the sides with benzene.

9. Pipet 0.5 ml into the Teflon cup and evaporate to dryness in a vacuum oven at 40° C for 3 hours.

10. Weigh the Teflon cup and the weight gain is due to the benzene soluble residue in half the Sample.

II. MEDICAL SURVEILLANCE GUIDELINES

A. *General.*

The minimum requirements for the medical examination for coke oven workers are given in paragraph (j) of the standard.

The initial examination is to be provided to all coke oven workers who work at least 30 days in the regulated area. The examination includes at 14" X 17" posterior-anterior chest x-ray and a ILO/UC rating to assure some standardization of x-ray reading, pulmonary function tests (FVC and FEV 1.0), weight, urinalysis, skin examination and a sputum and urinary cytologic examination. These tests are to serve as the baseline for comparing the employee's future test results. Periodic exams include all the elements of the initial exams except that the cytologic tests need be performed only on those employees who are 45 years of age or older or who have worked for 5 or more years in the related area; periodic exams are to be performed semiannually for this group instead of annually. The examination contents are minimum requirements, additional tests such as lateral and oblique x-rays or additional pulmonary function tests may be performed if deemed necessary.

B. *Pulmonary function tests.*

Pulmonary function tests should be performed in a manner which minimizes subject and operator bias. There has been shown to be learning effects with regard to the results obtained from certain tests, such as FEV 1.0. Best results can be obtained by multiple trials for each subject. The best of three trials or the average of the last three of five trials may be used in obtaining reliable results. The type of equipment used (manufacturer, model, etc.) should be recorded with the results as reliability and accuracy varies and such information may be important in the evaluation of test results. Care should be exercised to obtain the best possible testing equipment.

C. *Sputum cytology.*

Sputum can be collected by aerosol inhalation during the medical exam or by spontaneous early morning cough at home. Sputum is induced by transoral inhalation of an aerosolized solution of eight percent (8%) sodium chloride in water. After inhaling as few as three to five breaths the subject usually yields an adequate sputum specimen. A minimum of three samples should be collected by the subject at home. All sputum should be collected directly into sixty percent (60%) alcohol.

Scientific evidence suggests that chest x-rays and sputum cytology should be used together as screening tests for lung cancer in high risk populations, such as coke oven workers. The tests are to be performed every six months on workers who are 45 years of age or older or have worked in the regulated area for 5 or more years. Since the tests seem to be complementary, it may be advantageous to alternate the test procedures. For instance, chest x-rays could be obtained in June and December and sputum cytologys should be obtained in March and September. Facilities for providing necessary diagnostic investigation should be readily available as well as chest physicians, surgeons, radiologists, pathologists and immunotherapists to provide any necessary treatment services.

**§ 1910.1043 Cotton dust.**

(a) *Scope and application.* (1) This section applies to the control of employee exposure to cotton dust in all workplaces, except as provided in paragraph (a)(2).

(2) This section does not apply to: (i) The harvesting of cotton; (ii) the ginning of cotton (Exposure to cotton dust in cotton ginning is covered by § 1910.1046); (iii) maritime operations covered by 29 CFR Parts 1915, 1916, 1917, 1918; (iv) the handling or processing of woven or knitted materials; and (v) the handling or processing of washed cotton.

(3) This section provides mandatory requirements for the control of employee exposure to cotton dust. The mandatory nature of these requirements is not intended, however, to discourage or inhibit the development of different, equally effective means of providing the required protection. The variance provisions of section 6(d) of the Act, and the implementing regulations in Part 1905 of this Title, provide a mechanism for employers to obtain variances from the provisions of this section where the employer has developed alternative procedures which are "safe and healthful as" those required by this section. As implemented by the procedural regulations in Part 1905 of this Title, the variance provisions of the Act permit the flexibility which contributes to efficient compliance with the standard. To aid in the expeditious processing of variance applications, the procedures allow, where appropriate, for the grant of interim orders pending a decision on the merits of the variance as well as for the consideration of variances applicable to groups of employers. OSHA encourages interested employers to utilize the variance provisions of the Act where equally safe and healthful protective means are available.

(b) *Definitions.* For the purpose of this section:

"Assistant Secretary" means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor or designee;

"Blow down" means the cleaning of equipment and surfaces with compressed air.

"Cotton dust" means dust present in the air during the handling or processing of cotton, which may contain a mixture of many substances including ground up plant matter, fiber, bacteria, fungi, soil, pesticides, non-cotton plant matter and other contaminants which may have accumulated with the cotton during the growing, harvesting and subsequent processing or storage periods. Any dust present during the handling and processing of cotton through the weaving or knitting of fabrics, and dust present in other operations or manufacturing processes using new or waste cotton fibers or cotton fiber by-products from textile mills are considered cotton dust.

"Director" means the Director of the National Institute for Occupational Safety and Health (NIOSH), U.S. Department of Health, Education, and Welfare, or designee;

"Lint-free respirable cotton dust" means particles of cotton dust of approximately 15 microns or less aerodynamic equivalent diameter;

"Vertical elutriator cotton dust sampler" means a dust sampler which has a particle size cut-off at approximately 15 microns aerodynamic equivalent diameter when operating at the flow rate of 7.4±0.2 liters per minute;

"Yarn manufacturing" means all textile mill operations from opening to, but not including, slashing and weaving;

"Washed cotton" means cotton which has been thoroughly washed in hot water and is known in the cotton textile trade as purified or dyed. Washed cotton does not include steamed, autoclaved cotton or cotton washed solely in solvents.

(c) *Permissible exposure limits.* (1) The employer shall assure that no employee who is exposed to cotton dust in yarn manufacturing is exposed to airborne concentrations of lint-free respirable cotton dust greater than 200 ug/m³ mean concentration, averaged over an eight-hour period, as measured by a vertical elutriator or a method of equivalent accuracy and precision.

(2) The employer shall assure that no employee who is exposed to cotton dust in the textile processes known as slashing and weaving is exposed to airborne concentrations of lint-free respirable cotton dust greater than 750 ug/m³ mean concentration, averaged over an eight hour period, as measured by a vertical elutriator or a method of equivalent accuracy and precision.

(3) The employer shall assure that no employee who is exposed to cotton dust (except for exposures in yarn manufacturing and slashing and weaving covered by paragraphs (c)(1) and (c)(2)) is exposed to airborne concentrations of lint-free respirable cotton dust greater than 500 ug/m³ mean concentration, averaged over an eight-hour period, as measured by a vertical elutriator or a method of equivalent accuracy and precision.

(d) *Exposure monitoring and measurement*—(1) *General.* (i) For the purposes of this section, employee exposure is that exposure which would occur if the employee were not using a respirator.

(ii) The sampling device to be used shall be either the vertical elutriator cotton dust sampler or a method of equivalent accuracy and precision.

(iii) If an alternative to the vertical elutriator cotton dust sampler is used, the employer shall establish equivalency by demonstrating that the alternative sampling devices;

(*a*) Collect respirable particulates in the same range as the vertical elutriator (approximately 15 microns);

(*b*) Replicates exposure data in side-by-side field comparisons; and

(*c*) Are equivalent within an accuracy and precision range of plus or minus 25 percent for 95 percent of the samples over the range of 0.5 to 2 times the permissible exposure limit.

(2) *Initial monitoring.* Each employer who has a place of employment in which cotton dust is present, shall conduct monitoring by obtaining measurements which are representative of the exposure of all employees to airborne concentrations of lint-free respirable cotton dust over an eight-hour period. The sampling program shall include at least one determination during each shift for each work area.

(3) *Periodic monitoring.* (i) The employer shall repeat the measurements required by paragraph (d)(2) at least every six months.

(ii) Whenever there has been a production, process, or control change which may result in new or additional exposure to cotton dust, or whenever the employer has any other reason to suspect an increase in employee exposure, the employer shall repeat the monitoring and measurements required by paragraph (d)(2) for those employees affected, by the change or increase.

(4) *Employee notification.* (i) Within five working days after the receipt of monitoring results, the employer shall notify each employee in writing of the exposure measurements which represent that employee's exposure.

(ii) Whenever the results indicate that the employee's exposure exceeds the applicable permissible exposure limit specified in paragraph (c) the employer shall include in the written notice a statement that the permissible exposure limit was exceeded and a description of the corrective action taken to reduce exposure below the permissible exposure limit.

(e) *Methods of compliance*—(1) *Engineering and work practice controls.* The employer shall institute engineering and work practice controls to reduce and maintain employee exposure to cotton dust at or below the permissible exposure limit specified in paragraph (c), except to the extent that the employer establishes that such controls are not feasible.

(2) Whenever feasible engineering and work practice controls are not sufficient to reduce employee exposure to or below the permissible exposure limit, the employer shall nonetheless institute these controls to immediately reduce exposure to the lowest feasible level, and shall supplement these controls with the use of respirators which shall comply with the provisions of paragraph (f).

(3) *Compliance program.* (i) Each employer shall establish and implement a written program sufficient to reduce exposures as soon as possible to or below the permissible exposure limit solely by means of engineering controls and work practices as required by paragraph (e)(1) of this section.

(ii) The written program shall include at least the following:

(*a*) A description of each operation or process resulting in employee exposure to cotton dust;

(*b*) Engineering plans and other studies used to determine the controls for each process;

(*c*) A report of the technology considered in meeting the permissible exposure limit;

(*d*) Monitoring data obtained in accordance with paragraph (d) of this section;

(*e*) A detailed schedule for development and implementation of engineering and work practice controls, including exposure levels projected to be achieved by such controls;

(*f*) Work practice program; and

(*g*) Other relevant information.

(iii) The employer's schedule as set forth in the compliance program, shall project completion no later than September 4, 1982,

(iv) The employer shall complete the steps set forth in this program by the dates in the schedule.

(v) Written programs shall be submitted, upon request, to the Assistant Secretary and the Director, and shall be available at the worksite for examination and copying by the Assistant Secretary, the Director, and any affected employee or their designated representatives.

(vi) The written programs required under paragraph (e)(3) of this section shall be revised and updated at least every six months to reflect the current status of the program and current exposure levels.

(4) *Mechanical ventilation.* When mechanical ventilation is used to control exposure, measurements which demonstrate the effectiveness of the system to control exposure, such as capture velocity, duct velocity, or static pressure shall be made at least every six months. Measurements of the system's effectiveness to control exposures shall also be made within five days of any change in production, process or control which may result in any increase in airborne concentrations of cotton dust.

(f) *Use of respirators*—(1) *General.* Where the use of respirators is required under this section, the employer shall provide, at no cost to the employee, and assure the use of respirators which comply with the requirements of this paragraph (f). Respirators shall be used in the following circumstances:

(i) During the time periods necessary to install or implement feasible engineering controls and work practice controls;

(ii) During maintenance and repair activities in which engineering and work practice controls are not feasible;

(iii) In work situations where feasible engineering and work practice controls are not yet sufficient to reduce exposure to or below the permissible exposure limit; and

(iv) In operations specified under paragraph (g)(1).

(v) Whenever an employee requests a respirator.

(2) *Respirator selection.* (i) Where respirators are required under this section, the employer shall select the appropriate respirator from Table 1 below and shall assure that the employee uses the respirator provided.

TABLE I

| Cotton dust concentration | Required respirator |
|---|---|
| Not greater than— | |
| (a) 5 × the applicable permissible exposure limit. | 1. Any dust respirator, including single use |
| (b) 10 × the applicable permissible exposure limit. | 1. Any dust respirator, except single use or quarter mask; or<br>2. Any supplied air respirator; or<br>3. Any self-contained breathing apparatus. |
| (c) 50 × the applicable permissible exposure limit. | 1. High efficiency particulate filter respirator with a full facepiece; or<br>2. Any supplied air respirator with full-facepiece, helmet or hood; or<br>3. Any self-contained breathing apparatus with full-facepiece. |
| (d) Greater than 50 × the applicable permissible exposure limit. | 1. A powered air-purifying respirator with high efficiency particulate filter; or<br>2. A self-contained breathing apparatus with a full facepiece operated in pressure demand or other positive pressure mode; or<br>3. A type "C" supplied air respirator operated in pressure demand or other positive pressure mode; or<br>4. A combination respirator which includes a type C supplied-air respirator with a full facepiece operated in pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure demand or other positive pressure mode. |

(ii) The employer shall select respirators from those tested and approved for protection against dust by the National Institute for Occupational Safety and Health (NIOSH) under the provisions of 30 CFR Part 11.

(iii) Whenever respirators are required by this section for concentrations not greater than 50 × the applicable permissible exposure limit, the employer shall provide and permit the employee to use, at the employee's option, single use dust respirator in preference to any respirator specified in paragraph (a) of Table 1.

(iv) Whenever respirators are required by this section for concentrations not greater than 50 x the applicable permissible exposure limit, the employer shall, upon the request of the employee, provide a powered air purifying respirator with a high efficiency particulate filter in lieu of the respirator specified in paragraphs (a), (b), or (c) of Table I.

(v) Whenever a physician determines that an employee is unable to wear any form of respirator, including a power air purifying respirator, the employee shall be given the opportunity to transfer to another position which is available or which later becomes available having a dust level at or below the PEL. The employer shall assure than an employee who is transferred due to an inability to wear a respirator suffers no loss of earnings or other employment rights or benefits as a result of the transfer.

(vi) Until March 4, 1979, the employer shall provide any dust respirator, including single use, to all employees exposed to cotton dust, unless the employer has conducted the monitoring required by paragraph (d)(2) of this section or otherwise has monitored employee exposure. As soon as monitoring has been conducted, the employer shall select the appropriate respirator from Table I.

(3) *Respirator program.* The employer shall institute a respirator program in accordance with § 1910.134 (b), (d), (e), and (f) of this part.

(4) *Respirator usage.* (i) The employer shall assure that the respirator used by each employee exhibits minimum facepiece leakage and that the respirator is fitted properly.

(ii) The employer shall allow each employee who uses a filter respirator, to change the filter elements whenever an increase in breathing resistance is detected by the employee. The employer shall maintain an adequate supply of filter elements for this purpose.

(iii) The employer shall allow employees who wear respirators to wash their faces and respirator face pieces to prevent skin irritation associated with respirator use.

(g) *Work practices.* Each employer shall, regardless of the level of employee exposure, immediately establish and implement a written program of work practices, which shall minimize cotton dust exposure for each specific job. Where applicable, the following work practices shall be included in the work practices program:

(1) Compressed air "blow down" cleaning shall be prohibited, where alternative means are feasible. Where compressed air "blow down" is done, respirators shall be worn by the employees performing the "blow down", and employees in the area whose presence is not required to perform the "blow down" shall be required to leave the area during this cleaning operation.

(2) Cleaning of clothing or floors with compressed air shall be prohibited.

(3) Floor sweeping shall be performed with a vacuum or with methods designed to minimize dispersal of dust.

(4) Cotton and cotton waste shall be stacked, sorted, baled, dumped, removed or otherwise handled by mechanical means, except where the employer can show that it is infeasible to do so. Where infeasible, the method used for handling cotton and cotton waste shall be the method which reduces exposure to the lowest level feasible.

(5) The employer shall inspect, clean maintain, and repair, all engineering control equipment and ventilation systems including power sources, ducts, and filtration units of the equipment.

(h) *Medical surveillance.* (1) *General.* (i) Each employer who has a place of employment in which cotton dust is present shall institute a program of

medical surveillance for all employees exposed to cotton dust.

(ii) The employer shall assure that all medical examinations and procedures are performed by or under the supervision of a licensed physician and are provided without cost to the employee.

(iii) Persons other than licensed physicians, who administer the pulmonary function testing required by this section shall complete a NIOSH approved training course in spirometry.

(2) *Initial examinations.* The employer shall provide each employee who is or may be exposed to cotton dust with an opportunity for medical surveillance. For new employees, this examination shall be provided prior to initial assignment. The medical surveillance shall include at least the following:

(i) A medical history;

(ii) The standardized questionnaire contained in Appendix B; and

(iii) A pulmonary function measurement, including a determination of forced vital capacity (FVC) and forced expiratory volume in 1 second ($FEV_1$), and the percentage that the measured values of FEV and FVC differ from the predicted values, using the standard tables in Appendix C.

These determinations shall be made for each employee before the employee enters the workplace on the first day of the work week, following at least 35 hours after previous exposure to cotton dust. The tests shall be repeated during the shift, no sooner than 4 and no more than 10 hours after the beginning of the work shift; and, in any event, no more than one hour after cessation of exposure.

(iv) Based upon the questionnaire results, each employee shall be graded according to Schilling's byssinosis classification system.

(3) *Periodic examinations.* (i) The employer shall provide annual medical surveillance for all employees exposed to cotton dust which shall include at least an update of the medical history and standardized questionnaire and the pulmonary function measurements in paragraph (h)(2).

(ii) Medical surveillance as required in paragraph (h)(3)(i) shall be provided every six months for all employees in the following categories:

(*a*) An $FEV_1$ of greater than 80 percent of predicted, but with an $FEV_1$ decrement of 5 percent or 200 ml. on a first working day;

(*b*) An $FEV_1$ of less than 80 percent of the predicted value; or

(*c*) Where, in the opinion of the physician, any significant change in questionnaire findings, pulmonary function results, or other diagnostic tests has occurred.

(iii) An employee whose $FEV_1$ is less than 60 percent of the predicted value shall be referred to a physician for a detailed pulmonary examination.

(iv) A comparison shall be made between the current examination results and those of previous examinations and a determination made by the physician as to whether there has been a significant change.

(4) *Information provided to the physician.* The employer shall provide the following information to the examining physician:

(i) A copy of this regulation and its Appendices;

(ii) A description of the affected employee's duties as they relate to the employee's exposure;

(iii) The employee's exposure level or anticipated exposure level;

(iv) A description of any personal protective equipment used or to be used; and

(v) Information from previous medical examinations of the affected employee which is not readily available to the examining physician.

(5) *Physician's written opinion.*

(i) The employer shall obtain and furnish the employee with a copy of a written opinion from the examining physician containing the following:

(*a*) The results of the medical examination and tests;

(*b*) The physician's opinion as to whether the employee has any detected medical conditions which would place the employee at increased risk of material impairment of the employee's health from exposure to cotton dust;

(*c*) The physician's recommended limitations upon the employee's exposure to cotton dust or upon the employee's use of respirators including a determination of whether an employee can wear a negative pressure respirator, and he cannot, a determination of the employee's ability to wear a powered air purifying respirator; and,

(*d*) A statement that the employee has been informed by the physician of the results of the medical examination and any medical conditions which require further examination or treatment.

(ii) The written opinion obtained by the employer shall not reveal specific findings or diagnoses unrelated to occupational exposure.

(i) *Employee education and training.*

(1) *Training program.* (i) The employer shall provide a training program for all employees in all workplaces where cotton dust is present, and shall assure that each employee in these workplaces is informed of the following:

(*a*) The specific nature of the operations which could result in exposure to cotton dust at or above the permissible exposure limit;

(*b*) The measures, including work practices required by paragraph (g) of this section, necessary to protect the employee from exposures in excess of the permissible exposure limit;

(*c*) The purpose, proper use and limitations of respirators required by paragraph (f) of this section;

(*d*) The purpose for and a description of the medical surveillance program required by paragraph (h) of this section and other information which will aid exposed employees in understanding the hazards of cotton dust exposure; and

(*e*) The contents of this standard and its appendices.

(i) The training program shall be provided prior to initial assignment and shall be reported and shall be repeated at least annually.

(2) *Access to training materials.* (i) Each employer shall post a copy of this section with its appendices in a public location at the workplace, and shall, upon request, make copies available to employees.

(ii) The employer shall provide all materials relating to the employee training and information program to the Assistant Secretary and the Director upon request.

(iii) In addition to the information required by paragraph (i)(1), the employer shall include as part of the training program, and shall distribute to employees, any materials, pertaining to the Occupational Safety and Health Act, the regulations issued pursuant to that Act, and this cotton dust standard, which are made available to the employer by the Assistant Secretary.

(j) *Signs.* The employer shall post the following warning signs in each work area where the permissible exposure limit for cotton dust is exceeded:

**WARNING**

**COTTON DUST WORK AREA**

**May Cause Acute or Delayed Lung Injury**

**(Byssinosis)**

**RESPIRATORS**

**REQUIRED IN THIS AREA**

(k) *Recordkeeping.* (1) *Exposure measurements.* (i) The employer shall establish and maintain an accurate record of all measurements required by paragraph (d) of this section.

(ii) The record shall include: (*a*) A log containing the items listed in paragraph IV(a) of Appendix A, and the dates, number, duration, and results of each of the samples taken, including a description of the procedure used to determine representative employee exposures;

(*b*) The type of protective devices worn, if any, and length of time worn; and

(c) The names, social security numbers, job classifications, and exposure levels of employees whose exposure the measurement is intended to represent.

(iii) The employer shall maintain this record for at least 20 years.

(2) *Medical surveillance.* (i) The employer shall establish and maintain an accurate medical record for each employee subject to medical surveillance required by paragraph (h) of this section.

(ii) The record shall include:

(a) The name and social security number and description of the duties of the employee;

(b) A copy of the medical examination results including the medical history, questionnaire responses, results of all tests, and the physician's recommendation;

(c) A copy of the physician's written opinion;

(d) Any employee medical complaints related to exposure to cotton dust;

(e) A copy of this standard and its appendices, except that the employer may keep one copy of the standard and the appendices for all employees, provided that he references the standard and appendices in the medical surveillance record of each employee; and

(f) A copy of the information provided to the physician as required by paragraph (h)(4) of this section.

(iii) The employer shall maintain this record for at least 20 years.

(3) *Availability.* (i) The employer shall make all records required to be maintained by paragraph (k) of this section available to the Assistant Secretary and the Director for examination and copying.

(ii) The employer shall make employee exposure measurement records required by this section available to affected employees or their designated representatives for examination and copying.

(iii) The employer shall make all records as will indicate a former employee's own exposure to cotton dust available to the former employee or his designated representative for examination and copying.

(iv) The employer shall make an employee's medical records required to be maintained by this section, available to the affected employee or former employee or to a physician or other individual designated by such affected employee or former employees, for examination and copying.

(4) *Transfer of records.* (i) Whenever the employer ceases to do business, the successor employer shall receive and retain all records required to be maintained by paragraph (k) of this section.

(ii) Whenever the employer ceases to do business, and there is no successor employer to receive and retain the records for the prescribed period, these records shall be transmitted to the Director.

(iii) At the expiration of the retention period for the records required to be maintained by this section, the employer shall notify the Director at least 3 months prior to the disposal of such records and shall transmit those records to the Director if he requests them within that period.

(l) *Observation of monitoring.* (1) The employer shall provide affected employees or their designated representatives an opportunity to observe any measuring or monitoring of employee exposure to cotton dust conducted pursuant to paragraph (d) of this section.

(2) Whenever observation of the measuring or monitoring of employee exposure to cotton dust requires entry into an area where the use of personal protective equipment is required, the employer shall provide the observer with and assure the use of such equipment and shall require the observer to comply with all other applicable safety and health procedures.

(3) Without interfering with the measurement, observers shall be entitled to:

(i) An explanation of the measurement procedures;

(ii) An opportunity to observe all steps related to the measurement of airborne concentrations of cotton dust performed at the place of exposure; and

(iii) An opportunity to record the results obtained.

(m) *Effective date*—(1) *General.* This section is effective September 4, 1978, except as otherwise provided below.

(2) *Startup dates.* (i) *Initial monitoring.* The initial monitoring required by paragraph (d)(2) of this section shall be completed as soon as possible but no later than March 4, 1979.

(ii) *Methods of compliance: Engineering and work practice controls.* The engineering and work practice controls required by paragraph (e) of this section shall be implemented no later than September 4, 1982.

(iii) *Compliance program.* The compliance program required by paragraph (e)(3) of this section shall be established no later than September 4, 1979.

(iv) *Respirators.* The respirators required by paragraph (f) of this section shall be provided no later than October 4, 1978. Until September 4, 1979, the provisions of paragraph (f)(2)(vi) apply.

(v) *Work practices.* The work practices required by paragraph (g) of this section shall be implemented no later than December 4, 1978.

(iv) *Medical surveillance.* This initial medical surveillance required by paragraph (h) of this section shall be completed no later than September 4, 1979.

(vii) *Employee education and training.* The initial education and training required by paragraph (i) of this section shall be completed as soon as possible but no later than December 4, 1978.

(n) *Appendices.* (i) Appendices B, C, and D to this section are incorporated as part of this section and the contents of these appendices are mandatory.

(ii) Appendix A contains information which is not intended to create any additional obligations not otherwise imposed or to detract from any existing obligations.

## Appendix A—Air Sampling and Analytical Procedures for Determining Concentrations of Cotton Dust

### I. SAMPLING LOCATIONS

The sampling procedures must be designed so that samples of the actual dust concentrations are collected accurately and consistently and reflect the concentrations of dust at the place and time of sampling. Sufficient number of 6-hour area samples in each distinct work area of the plant should be collected at locations which provide representative samples of air to which the worker is exposed. In order to avoid filter overloading, sampling time may be shortened when sampling in dusty areas. Samples in each work area should be gathered simultaneously or sequentially during a normal operating period. The daily time-weighted average (TWA) exposure of each worker can then be determined by using the following formula:

$$\frac{\text{Summation of hours spent in each location and the dust concentration in that location.}}{\text{Total hours exposed}}$$

A time-weighted average concentration should be computed for each worker and properly logged and maintained on file for review.

### II. SAMPLING EQUIPMENT

(a) Sampler. The instrument selected for monitoring is the Lumsden-Lynch vertical elutriator. It should operate at a flow rate of $7.4 \pm 0.2$ liters/minute.

The samplers should be cleaned prior to sampling. The pumps should be monitored during sampling.

(b) Filter Holder. A three-piece cassette constructed of polystyrene designed to hold a 37-mm diameter filter should be used. Care must be exercised to insure that an adequate seal exists between elements of the cassette.

(c) Filers and Support Pads. The membrane filters used should be polyvinyl chloride with a 5-um pore size and 37-mm diameter. A support pad, commonly called a backup pad, should be used under the filter membrane in the field monitor cassette.

(d) Balance. A balance sensitive to 10 micrograms should be used.

III. INSTRUMENT CALIBRATION PROCEDURE

Samplers shall be calibrated when first received from the factory, after repair, and after receiving any abuse. The samplers should be calibrated in the laboratory both before they are used in the field and after they have been used to collect a large number of field samples. The primary standard, such as a spirometer or other standard calibrating instruments such as a wet test meter or a large bubble meter or dry gas meter, should be used. Instructions for calibration with the wet test meter follow. If another calibration device is selected, equivalent procedures should be used:

(a) Level wet test meter. Check the water level which should just touch the calibration point at the left side of the meter. If water level is low, add water 1-2° F. warmer than room temperature of till point. Run the meter for 30 minutes before calibration;

(b) Place the polyvinyl chloride membrane filter in the filter cassette;

(c) Assemble the calibration sampling train;

(d) Connect the wet test meter to the train.

The pointer on the meter should run clockwise and a pressure drop of not more than 1.0 inch of water indicated. If the pressure drop is greater than 1.0, disconnect and check the system;

(e) Operate the system for ten minutes before starting the calibration;

(f) Check the vacuum gauge on the pump to insure that the pressure drop across the orifice exceeds 16 inches of mercury;

(g) Record the following on calibration data sheets:

(1) Wet test meter reading, start and finish;

(2) Elapsed time, start and finish (at least two minutes);

(3) Pressure drop at manometer;

(4) Air temperature;

(5) Barometric pressure; and

(6) Limiting orifice number;

(h) Calculate the flow rate and compare against the flow of $7.4 \pm 0.2$ liters/minute. If flow is between these limits, perform calibration again, average results, and record orifice number and flow rate. If flow is not within these limits, discard or modify orifice and repeat procedure;

(i) Record the name of the person performing the calibration, the date, serial number of the wet test meter, and the number of the critical orifices being calibrated.

IV. SAMPLING PROCEDURE

(a) Sampling data sheets should include a log of:

(1) The date of the sample collection;

(2) The time of sampling;

(3) The location of the sampler;

(4) The sampler serial number;

(5) The cassette number;

(6) The time of starting and stopping the sampling and the duration of sampling;

(7) The weight of the filter before and after sampling;

(8) The weight of dust collected (corrected for controls);

(9) The dust concentration measured;

(10) Other pertinent information; and

(11) Name of person taking sample

(b) Assembly of filter cassette should be as follows:

(1) Loosely assemble 3-piece cassette;

(2) Number cassette;

(3) Place absorbant pad in cassette;

(4) Weigh filter to an accuracy of 10 μg;

(5) Place filter in cassette;

(6) Record weight of filter in log, using cassette number for identification;

(7) Fully assemble cassette, using pressure to force parts tightly together;

(8) Install plugs top and bottom;

(9) Put shrink band on cassette, covering joint between center and bottom parts of cassette; and

(10) Set cassette aside until shrink band dries thoroughly.

(c) Sampling collection should be performed as follows:

(1) Clean lint out of the motor and elutriator;

(2) Install vertical elutriator in sampling locations specified above with inlet 4½ to 5½ feet from floor (breathing zone height);

(3) Remove top section of cassette;

(4) Install cassette in ferrule of elutriator;

(5) Tape cassette to ferrule with masking tape or similar material for air-tight seal;

(6) Remove bottom plug of cassette and attach hose containing critical orifice;

(7) Start elutriator pump and check to see if gauge reads above 14 in. of Hg vacuum;

(8) Record starting time, cassette number, and sampler number;

(9) At end of sampling period stop pump and record time; and

(10) Controls with each batch of samples collected, two additional filter cassettes should be subjected to exactly the same handling as the samples, except that they are not opened. These control filters should be weighed in the same manner as the sample filters.

Any difference in weight in the control filters would indicate that the procedure for handling sample filters may not be adequate and should be evaluated to ascertain the cause of the difference, whether and what necessary corrections must be made, and whether additional samples must be collected.

(d) Shipping. The cassette with samples should be collected, along with the appropriate number of blanks, and shipped to the analytical laboratory in a suitable container to prevent damage in transit.

(e) Weighing of the sample should be achieved as follows:

(1) Remove shrink band;

(2) Remove top and middle sections of cassette and botton plug;

(3) Remove filter from cassette and weigh to an accuracy of 10 μg; and

(4) Record weight in log against original weight

(f) Calculation of volume of air sampled should be determined as follows:

(1) From starting and stopping times of sampling period, determine length of time in minutes of sampling period; and

(2) Multiply sampling time in minutes by flow rate of critical orifice in liters per minute and divide by 1000 to find air quantity in cubic meters.

(g) Calculation of Dust Concentrations should be made as follows:

(1) Substract weight of clean filter from dirty filter and apply control correction to find actual weight of sample. Record this weight (in μg) in log; and

(2) Divide mass of sample in μg by air volume in cubic meters to find dust concentration in μg/m. Record in log.

[4510-26-C]

# APPENDIX B-1
# RESPIRATORY QUESTIONNAIRE

## A. IDENTIFICATION DATA

PLANT_____ SOCIAL SECURITY NO. _____
DAY MONTH (figures) YEAR (last 2 digits)

NAME _____ DATE OF INTERVIEW _____
(Surname)

_____ DATE OF BIRTH _____
(First Names) M F

ADDRESS _____ AGE _____ (8,9) SEX _____ (10)

_____ RACE | W | N | IND. | OTHER | (11)

INTERVIEWER: 1 2 3 4 5 6 7 8 (12)

WORK SHIFT: 1st _____ 2nd _____ 3rd _____ (13) STANDING HEIGHT _____ (14,15)

PRESENT WORK AREA WEIGHT _____ (16,18)

If working in more than one specified work area, X area where most of the work shift is spent. If "other," but spending 25% of the work shift in one of the specified work areas, classify in that work area. If carding department employee, check area within that department where most of the work shift is spent (if in doubt, check "throughout"). For work areas such as spinning and weaving where many work rooms may be involved, be sure to check the specific work room to which the employee is assigned – if he works in more than one work room within a department classify as 7 (all) for that department.

| | Workroom Number | (19) Open | (20) Pick | Area | (21) Card #1 | (22) #2 | (23) Spin | (24) Wind | (25) Twist | (26) Spool | (27) Warp | (28) Slash | (29) Weave | (30) Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT RISK (cotton & cotton blend) | 1 | | | Cards | | | | | | | | | | |
| | 2 | | | Draw | | | | | | | | | | |
| | 3 | | | Comb | | | | | | | | | | |
| | 4 | | | Rove | | | | | | | | | | |
| | 5 | | | Thru Out | | | | | | | | | | |
| | 6 | | | | | | | | | | | | | |
| | 7 (all) | | | | | | | | | | | | | |
| Control (synthetic & wool) | 8 | | | | | | | | | | | | | |
| Ex-Worker (cotton) | 9 | | | | | | | | | | | | | |

Use actual wording of each question. Put X in appropriate square after each question. When in doubt record 'No'. When no square, circle appropriate answer.

**B. COUGH**

(on getting up)†

Do you usually cough first thing in the morning? _____ Yes ___ No ___ (31)
(Count a cough with first smoke or on "first going out of doors." Exclude clearing throat or a single cough.)

Do you usually cough during the day or at night? _____ Yes ___ No ___ (32)
(Ignore an occasional cough.)

If 'Yes' to either question (31-32):

Do you cough like this on most days for as much as three months a year? _____ Yes ___ No ___ (33)

Do you cough on any particular day of the week? Yes ___ No ___ (34)

(1) (2) (3) (4) (5) (6) (7)

If 'Yes': Which day? Mon. Tues. Wed. Thur. Fri. Sat Sun. (35)

---

**C. PHLEGM** or alternative word to suit local custom.

(on getting up)†

Do you usually bring up any phlegm from your chest first thing in the morning? (Count phlegm with the first smoke or on "first going out of doors." Exclude phlegm from the nose. Count swallowed phlegm.) _____ Yes ___ No ___ (36)

Do you usually bring up any phlegm from your chest during the day or at night? (Accept twice or more.) _____ Yes ___ No ___ (37)

If 'Yes' to either question (36) or (37):

Do you bring up phlegm like this on most days for as much as three months each year? _____ Yes ___ No ___ (38)

If 'Yes' to question (33) or (38):

(cough) How long have you had this phlegm? (Write in number of years

(1) ☐ 2 years or less (39)
(2) ☐ More than 2 years-9 years
(3) ☐ 10-19 years
(4) ☐ 20+ years

†These words are for subjects who work at night

---

**D. CHEST ILLNESSES**

In the past three years, have you had a period of (increased) †cough and phlegm lasting for 3 weeks or more? _____

(1) ☐ No (40)
(2) ☐ Yes, only one period
(3) ☐ Yes, two or more periods

†For subjects who usually have phlegm

During the past 3 years have you had any chest illness which has kept you off work, indoors at home or in bed? (For as long as one week, flu?) Yes ___ No ___ (41)

If 'Yes' to (41): Did you bring up (more) phlegm than usual in any of these illnesses? Yes ___ No ___ (42)

If 'Yes' to (42): During the past three years have you had:
Only one such illness with increased phlegm? (1) ☐ (43)

More than one such illness: (2) ☐ (44)

Br. Grade _____

E. TIGHTNESS

Does your chest ever feel tight or your breathing become difficult? _____ Yes _____ No _____ (45)

Is your chest tight or your breathing difficult on any particular day of the week? (after a week or 10 days away from the mill) _____ Yes _____ No _____ (46)

If 'Yes': Which day? Mon. (3) Tues. (4) Wed. (5) Thur. (6) Fri. (7) Sat. (8) Sun. (47)

(1) Sometimes (2) Always

If 'Yes' Monday: At what time on Monday does your chest feel tight or your breathing difficult? (48)

1 ☐ Before entering the mill

2 ☐ After entering the mill

(Ask only if NO to Question (45)

In the past, has your chest ever been tight or your breathing difficult on any particular day of the week? _____ Yes _____ No _____ (49)

If 'Yes': Which day? Mon. (3) Tues. (4) Wed. (5) Thur. (6) Fri. (7) Sat. (8) Sun. (50)

(1) Sometimes (2) Always

F. BREATHLESSNESS

If disabled from walking by any condition other than heart or lung disease put "X" here and leave questions (52-60) unasked. ☐ (51)

Are you ever troubled by shortness of breath, when hurrying on the level or walking up a slight hill? _____ Yes _____ No _____ (52)

If 'No', grade is 1. If 'Yes', proceed to next question

Do you get short of breath walking with other people at an ordinary pace on the level? _____ Yes _____ No _____ (53)

If 'No', grade is 2. If 'Yes', proceed to next question

Do you have to stop for breath when walking at your own pace on the level? _____ Yes _____ No _____ (54)

If 'No', grade is 3. If 'Yes', proceed to next question

Are you short of breath on washing or dressing? _____ Yes _____ No _____ (55)

If 'No', grade is 4. If 'Yes', grade is 5.

Dyspnea Grd. _____ (56)

ON MONDAYS:

Are you ever troubled by shortness of breath, when hurrying on the level or walking up a slight hill? _____ Yes _____ No _____ (57)

If 'No', grade is 1. If 'Yes', proceed to next question

Do you get short of breath walking with other people at an ordinary pace on the level? _____ Yes _____ No _____ (58)

If 'No', grade is 2. If 'Yes', proceed to next question

Do you have to stop for breath when walking at your own pace on the level? _____ Yes _____ No _____ (59)

If 'No', grade is 3. If 'Yes', proceed to next question

Are you short of breath on washing or dressing? _____ Yes _____ No _____ (60)

If 'No', grade is 4. If 'Yes', grade is 5

B. Grd. _____ (61)

G. OTHER ILLNESSES AND ALLERGY HISTORY

Do you have a heart condition for which you are under a doctor's care? _____ Yes _____ No ____ (62)

Have you ever had asthma? Yes No (63)

If 'Yes', did it begin: (1) ☐ Before age 30

(2) ☐ After age 30

If 'Yes' before 30: did you have asthma before ever going to work in a textile mill? _____ Yes _____ No ____ (64)

Have you ever had hay fever or other allergies (other than above)? _____ Yes _____ No ____ (65)

H. TOBACCO SMOKING*

Do you smoke?

Record 'Yes' if regular smoker up to one month ago. (Cigarettes, cigar or pipe) _____ Yes _____ No ____ (66)

If 'No' to (63).

Have you ever smoked? (Cigarettes, cigars, pipe. Record 'No' if subject has never smoked as much as one cigarette a day, or 1 oz. of tobacco a month, for as long as one year.) _____ Yes _____ No ____ (67)

If 'Yes' to (63) or (64); what have you smoked and for how many years? (Write in specific number of years in the appropriate square)

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | |
|---|---|---|---|---|---|---|---|---|---|---|
| Years | (<5) | (5-9) | (10-14) | (15-19) | (20-24) | (25-29) | (30-34) | (35-39) | (>40) | |
| Cigarettes | | | | | | | | | | (68) |
| Pipe | | | | | | | | | | (69) |
| Cigars | | | | | | | | | | (70) |

If cigarettes, how many packs per day? (Write in number of cigarettes)

(1) ☐ less than 1/2 pack (71)
(2) ☐ 1/2 pack, but less than 1 pack
(3) ☐ 1 pack, but less than 1-1/2 packs
(4) ☐ 1-1/2 packs or more

Number of pack years: _____ (72,73)

If an ex-smoker (cigarettes, cigar or pipe), how long since you stopped? _____ (74)
(Write in number of years)

(1) ☐ 0-1 year
(2) ☐ 1-4 years
(3) ☐ 5-9 years
(4) ☐ 10+ years

*Have you changed your smoking habits since last interview? If yes, specify what changes.

I. OCCUPATIONAL HISTORY**

Have you ever worked in: A foundry? (As long as one year) _____ Yes _____ No ____ (75)

Stone or mineral mining, quarrying or processing? (As long as one year) _____ Yes _____ No ____ (76)

Asbestos milling or processing? (Ever) _____ Yes _____ No ____ (77)

Other dusts, fumes or smoke? If yes, specify: _____ Yes _____ No ____ (78)

Type of exposure _____

Length of exposure _____

**Ask only on first interview.

At what age did you first go to work in a textile mill? (Write in specific age in appropriate square).

| (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|
| <20 | 20-24 | 25-29 | 30-34 | 35-39 | 40+ |
| | | | | | |

When you first worked in a textile mill, did you work with (1) ☐ Cotton or cotton blend (79)

(2) ☐ Synthetic or wool (80)

APPENDIX B-II

Respiratory Questionnaire
for
Non-Textile Workers for the
Cotton Industry

| Identification No. | Interviewer Code |
|---|---|
| Location | Date of Interview |

A. IDENTIFICATION

| 1. NAME (Last) (First) (Middle Initial) | 3. PHONE NUMBER AREA CODE ( ) NO. | 4. SOCIAL SECURITY # (optional see below) |
|---|---|---|
| 2. CURRENT ADDRESS (Number, Street, or Rural Route, City or Town, County, State, Zip Code) | 5. BIRTHDATE (Mo., Day, Yr.) | 6. AGE LAST BIRTHDAY |
| | 7. SEX<br>1 ☐ Male 2 ☐ Female | |
| | 8. ETHNIC GROUP OR ANCESTRY<br>1. ☐ White, not of Hispanic Origin<br>2. ☐ Black, not of Hispanic Origin<br>3. ☐ Hispanic<br>4. ☐ American Indian or Alaskan Native<br>5. ☐ Asian or Pacific Islander<br>6. ☐ Other: _____ | |

| 9. STANDING HEIGHT | 10. WEIGHT | 11. WORK SHIFT |
|---|---|---|
| _____ (cm) | _____ | 1st ☐ 2nd ☐ 3rd ☐ |

12. PRESENT WORK AREA

Please indicate primary assigned work area and percent of time spent at that site. If at other locations, please indicate and note percent of time for each.

| | |
|---|---|
| PRIMARY WORK AREA | |
| SPECIFIC JOB | |

13. APPROPRIATE INDUSTRY

1 ☐ Garnetting
2 ☐ Cottonseed Oil Mill
3 ☐ Cotton Warehouse
4 ☐ Utilization
5 ☐ Cotton Classification
6 ☐ Cotton Ginning

(Furnishing your Social Security number is voluntary. Your refusal to provide this number will not affect any right, benefit, or privilege to which you would be entitled if you did provide your Social Security number. Your Social Security number is being requested since it will permit use in future determinations in statistical research studies.)

B. OCCUPATIONAL HISTORY TABLE

Complete the following table showing the entire work history of the individual from present to initial employment. Sporadic, part-time periods of employment, each of no significant duration, should be grouped if possible.

| INDUSTRY AND LOCATION | TENURE OF EMPLOYMENT | | SPECIFIC OCCUPATION | AVERAGE NO. DAYS WORKED PER WEEK | HAZARDOUS HEALTH EXPOSURE ASSOCIATED WITH WORK | | |
|---|---|---|---|---|---|---|---|
| | FROM 19__ | TO 19__ | | | YES | NO | IF YES, DESCRIBE |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

## C. SYMPTOMS

Use actual wording of each question. Put X in appropriate square after each question. When in doubt record "No".

COUGH

1. Do you usually cough first thing in the morning? (on getting up)* (Count a cough with first smoke or on "first going out of doors". Exclude clearing throat or a single cough.) 1 ☐ Yes 2 ☐ No

2. Do you usually cough during the day or at night? (Ignore an occasional cough.) 1 ☐ Yes 2 ☐ No

If YES to either question 1 or 2:

3. Do you cough like this on most days for as much as three months a year? 1 ☐ Yes 2 ☐ No 9 ☐ NA

4. Do you cough on any particular day of the week? 1 ☐ Yes 2 ☐ No

If YES:

5. Which day? Mon. Tue. Wed. Thur. Fri. Sat. Sun. _____.

PHLEGM

6. Do you usually bring up any phlegm from your chest first thing in the morning? (on getting up)* (Count phlegm with the first smoke or on "first going out of doors." Exclude phlegm from the nose. Count swallowed phlegm.) 1 ☐ Yes 2 ☐ No

7. Do you usually bring up any phlegm from your chest during the day or at night? (Accept twice or more.) 1 ☐ Yes 2 ☐ No

If YES to either question 6 or 7:

8. Do you bring up phlegm like this on most days for as much as three months each year? 1 ☐ Yes 2 ☐ No

If YES to question 3 or 8:

9. How long have you had this phlegm? (cough) (Write in number of years)

(1) ☐ 2 years or less
(2) ☐ More than 2 years - 9 years
(3) ☐ 10-19 years
(4) ☐ 20+ years

*These words are for subjects who work at night

CHEST ILLNESS

10. In the past three years, have you had a period of (increased) cough and phlegm lasting for 3 weeks or more?
(1) ☐ No
(2) ☐ Yes, only one period
(3) ☐ Yes, two or more periods

For subjects who usually have phlegm:

11. During the past 3 years have you had any chest illness which has kept you off work, indoors at home or in bed? (For as long as one week, flu?) 1 ☐ Yes 2 ☐ No

If YES to 11:

12. Did you bring up (more) phelgm than usual in any of these illnesses? 1 ☐ Yes 2 ☐ No

If YES to 12: During the past three years have you had:

13. Only one such illness with increased phelgm? 1 ☐ Yes 2 ☐ No

14. More than one such illness: 1 ☐ Yes 2 ☐ No

Br. Brade _____

TIGHTNESS

15. Does your chest ever feel tight or your breathing become difficult? 1 ☐ Yes 2 ☐ No

16. Is your chest tight or your breathing difficult on any particular day of the week? (after a week or 10 days away from the mill) 1 ☐ Yes 2 ☐ No

17. If YES, Which day? Mon. (3) Tues. (4) Wed. (5) Thur. (6) Fri. (7) Sat. (8) Sun.
(1) Sometimes (2) Always

18. If YES Monday: At what time on Monday does your chest feel tight or your breathing difficult?
☐ Before entering mill
☐ After entering mill

(ASK ONLY IF NO TO QUESTION 15)

19. In the past, has your chest ever been tight or your breathing difficult on any particular day of the week? 1 ☐ Yes 2 ☐ No

20. If YES, Which day? Mon. (3) Tues. (4) Wed. (5) Thur. (6) Fri. (7) Sat. (8) Sun.
(1) Sometimes (2) Always

BREATHLESSNESS

21. If disabled from walking by any condition other than heart or lung disease put "X" in the space and leave questions (22-30) unasked. ☐

22. Are you ever troubled by shortness of breath, when hurrying on the level or walking up a slight hill? 1 ☐ Yes 2 ☐ No

If NO, grade is 1. If YES, proceed to next question

23. Do you get short of breath walking with other people at an ordinary pace on the level? 1 ☐ Yes 2 ☐ No

If NO, grade is 2. If YES, proceed to next question

24. Do you have to stop for breath when walking at your own pace on the level? 1 ☐ Yes 2 ☐ No

If NO, grade is 3. If YES, proceed to next question

25. Are you short of breath on washing or dressing? 1 ☐ Yes 2 ☐ No

If NO, grade is 4. If YES, grade is 5.

26. Dyspnea Grd. _____

ON MONDAYS:

27 Are you ever troubled by shortness of breath, when hurrying on the level or walking up a slight hill? 1 ☐ Yes 2 ☐ No

If NO, grade is 1. If YES, proceed to next question

28. Do you get short of breath walking with other people at an ordinary pace on the level? 1 ☐ Yes 2 ☐ No

If NO, grade is 2, If YES, proceed to next question

29. Do you have to stop for breath when walking at your own pace on the level? 1 ☐ Yes 2 ☐ No

If NO, grade is 3. If YES, proceed to next question

30. Are you short of breath on washing or dressing? 1 ☐ Yes 2 ☐ No

If NO, grade is 4. If YES, grade is 5

31. B. Grd. _____

OTHER ILLNESSES AND ALLERGY HISTORY

32. Do you have a heart condition for which you are under a doctor's care? 1 ☐ Yes 2 ☐ No

OTHER ILLNESSES AND ALLERGY HISTORY CONTINUED:

33. Have you ever had asthma? 1 ☐ Yes 2 ☐ No

If yes, did it begin: (1) Before age 30 ☐

(2) After age 30 ☐

34. If yes before 30: did you have asthma before ever going to work in a textile mill? 1 ☐ Yes 2 ☐ No

35. Have you ever had hay fever or other allergies (other than above)? 1 ☐ Yes 2 ☐ No

TOBACCO SMOKING

36. Do you smoke? Record Yes if regular smoker up to one month ago. (Cigarettes, cigar or pipe) 1 ☐ Yes 2 ☐ No

If NO to (33).

37. Have you ever smoked? (Cigarettes, cigars, pipe. Record NO if subject has never smoked as much as one cigarette a day, or 1 oz. of tobacco a month, for as long as one year.) 1 ☐ Yes 2 ☐ No

If Yes to (33) or (34); what have you smoked for how many years? (Write in specific number of years in the appropriate square)

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| Years | (<5) | (5-9) | (10-14) | (15-19) | (20-24) | (25-29) | (30-34) | (35-39) | (>40) |
| 38. Cigarettes | | | | | | | | | |
| 39. Pipe | | | | | | | | | |
| 40. Cigars | | | | | | | | | |

41. If cigarettes, how many packs per day? Write in number of cigarettes _____

☐ Less than 1/2 pack
☐ 1/2 pack, but less than 1 pack
☐ 1 pack, but less than 1 1/2 packs
☐ 1-1/2 packs or more

42. Number of pack years: _____

43. If an ex-smoker (cigarettes, cigar or pipe), how long since you stopped? (Write in number of years.) _____

☐ 0-1 year
☐ 1-4 years
☐ 5-9 years
☐ 10+ years

OCCUPATIONAL HISTORY

Have you ever worked in:

44. A foundry? (As long as one year) 1 ☐ Yes 2 ☐ No

45. Stone or mineral mining, quarrying or processing? (As long as one year) 1 ☐ Yes 2 ☐ No

46. Asbestos milling or processing? (Ever) 1 ☐ Yes 2 ☐ No

47. Cotton or cotton blend mill? (For controls only) 1 ☐ Yes 2 ☐ No

48. Other dusts, fumes or smoke? If yes, specify. 1 ☐ Yes 2 ☐ No

Type of exposure _____

Length of exposure _____

# APPENDIX B-III

## ABBREVIATED RESPIRATORY QUESTIONNAIRE

### A. IDENTIFICATION DATA

PLANT_____ SOCIAL SECURITY NO. _____
DAY MONTH (figures) YEAR (last 2 digits)

NAME_____ DATE OF INTERVIEW_____
(Surname)

_____ DATE OF BIRTH_____
(First Names) M F

ADDRESS_____ AGE_____(8,9) SEX_____(10)

_____ RACE | W | N | IND. | OTHER | (11)

INTERVIEWER: 1 2 3 4 5 6 7 8 (12)

WORK SHIFT: 1st_____ 2nd_____ 3rd_____(13) STANDING HEIGHT_____(14,15)

PRESENT WORK AREA WEIGHT_____(16,18)

If working in more than one specified work area, X area where most of the work shift is spent. If "other," but spending 25% of the work shift in one of the specified work areas, classify in that work area. If carding department employee, check area within that department where most of the work shift is spent (if in doubt, check "throughout"). For work areas such as spinning and weaving where many work rooms may be involved, be sure to check the specific work room to which the employee is assigned — if he works in more than one work room within a department classify as 7 (all) for that department.

| | Workroom Number | (19) Open | (20) Pick | Area | (21) Card #1 | (22) #2 | (23) Spin | (24) Wind | (25) Twist | (26) Spool | (27) Warp | (28) Slash | (29) Weave | (30) Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT RISK (cotton & cotton blend) | 1 | | | Cards | | | | | | | | | | |
| | 2 | | | Draw | | | | | | | | | | |
| | 3 | | | Comb | | | | | | | | | | |
| | 4 | | | Rove | | | | | | | | | | |
| | 5 | | | Thru Out | | | | | | | | | | |
| | 6 | | | | | | | | | | | | | |
| | 7 (all) | | | | | | | | | | | | | |
| Control (synthetic & wool) | 8 | | | | | | | | | | | | | |
| Ex-Worker (cotton) | 9 | | | | | | | | | | | | | |

Use actual wording of each question. Put X in appropriate square after each question. When in doubt record 'No'. When no square, circle appropriate answer.

B. COUGH

Do you usually cough first thing in the morning? (on getting up)† Yes___ No___ (31)
(Count a cough with first smoke or on "first going out of doors." Exclude clearing throat or a single cough.)

Do you usually cough during the day or at night? Yes___ No___ (32)
(Ignore an occasional cough.)

If 'Yes' to either question (31-32):

Do you cough like this on most days for as much as three months a year? Yes___ No___ (33)

Do you cough on any particular day of the week? Yes___ No___ (34)

(1) (2) (3) (4) (5) (6) (7)

If 'Yes': Which day? Mon. Tues. Wed. Thur. Fri. Sat Sun. (35)

---

C. PHLEGM or alternative word to suit local custom.

Do you usually bring up any phlegm from your chest first thing in the morning? (Count phlegm with the first smoke or on "first going out of doors." Exclude phlegm from the nose. Count swallowed phlegm.) (on getting up)† Yes___ No___ (36)

Do you usually bring up any phlegm from your chest during the day or at night? (Accept twice or more.) Yes___ No___ (37)

If 'Yes' to either question (36) or (37):

Do you bring up phlegm like this on most days for as much as three months each year? Yes___ No___ (38)

If 'Yes' to question (33) or (38):

How long have you had this phlegm? (cough)
(Write in number of years

(1) ☐ 2 years or less
(2) ☐ More than 2 years-9 years
(3) ☐ 10-19 years
(4) ☐ 20+ years

†These words are for subjects who work at night

---

D. TIGHTNESS

Does your chest ever feel tight or your breathing become difficult? Yes___ No___ (39)

Is your chest tight or your breathing difficult on any particular day of the week? (after a week or 10 days away from the mill) Yes___ No___ (40)

If 'Yes': Which day? Mon. (1) Tues. (2) Wed. (3) Thur. (4) Fri. (5) Sat. (6) Sun. (7) (8) (41)
Sometimes / Always

If 'Yes' Monday: At what time on Monday does your chest feel tight or your breathing difficult? (42)
1 ☐ Before entering the mill
2 ☐ After entering the mill

(Ask only if NO to Question (45)

In the past, has your chest ever been tight or your breathing difficult on any particular day of the week? Yes___ No___ (43)

If 'Yes': Which day? Mon. (1) Tues. (2) Wed. (3) Thur. (4) Fri. (5) Sat. (6) Sun. (7) (8) (44)
Sometimes / Always

E. TOBACCO SMOKING

*Have you changed your smoking habits since last interview? If yes, specify what changes.

## APPENDIX C - SPIROMETRY PREDICTION TABLES FOR NORMAL MALES AND FEMALES

TABLE 1.- PREDICTED FVC FOR MALES (KNUDSON, ET AL.: AM REV RESPIR DIS. 1976, 113, 587.)

| HT | AGE 17 | 19 | 21 | 23 | 25 | 27 | 29 | 31 | 33 | 35 | 37 | 39 | 41 | 43 | 45 | 47 | 49 | 51 | 53 | 55 | 57 | 59 | 61 | 63 | 65 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 60.0 | 3.44 | 3.59 | 3.75 | 3.91 | 3.72 | 3.66 | 3.61 | 3.55 | 3.49 | 3.43 | 3.37 | 3.32 | 3.26 | 3.20 | 3.14 | 3.08 | 3.03 | 2.97 | 2.91 | 2.85 | 2.79 | 2.74 | 2.68 | 2.62 | 2.56 |
| 60.5 | 3.50 | 3.66 | 3.81 | 3.97 | 3.80 | 3.75 | 3.69 | 3.63 | 3.57 | 3.51 | 3.46 | 3.40 | 3.34 | 3.28 | 3.22 | 3.17 | 3.11 | 3.05 | 2.99 | 2.93 | 2.88 | 2.82 | 2.76 | 2.70 | 2.64 |
| 61.0 | 3.56 | 3.72 | 3.88 | 4.03 | 3.89 | 3.83 | 3.77 | 3.71 | 3.66 | 3.60 | 3.54 | 3.48 | 3.42 | 3.37 | 3.31 | 3.25 | 3.19 | 3.13 | 3.08 | 3.02 | 2.96 | 2.90 | 2.84 | 2.79 | 2.73 |
| 61.5 | 3.63 | 3.78 | 3.94 | 4.10 | 3.97 | 3.91 | 3.85 | 3.80 | 3.74 | 3.68 | 3.62 | 3.56 | 3.51 | 3.45 | 3.39 | 3.33 | 3.27 | 3.22 | 3.16 | 3.10 | 3.04 | 2.98 | 2.93 | 2.87 | 2.81 |
| 62.0 | 3.69 | 3.85 | 4.00 | 4.16 | 4.05 | 3.99 | 3.94 | 3.88 | 3.82 | 3.76 | 3.70 | 3.65 | 3.59 | 3.53 | 3.47 | 3.41 | 3.36 | 3.30 | 3.24 | 3.18 | 3.12 | 3.07 | 3.01 | 2.95 | 2.89 |
| 62.5 | 3.76 | 3.91 | 4.07 | 4.22 | 4.13 | 4.08 | 4.02 | 3.96 | 3.90 | 3.84 | 3.79 | 3.73 | 3.67 | 3.61 | 3.55 | 3.50 | 3.44 | 3.38 | 3.32 | 3.26 | 3.21 | 3.15 | 3.09 | 3.03 | 2.97 |
| 63.0 | 3.82 | 3.97 | 4.13 | 4.29 | 4.22 | 4.16 | 4.10 | 4.04 | 3.99 | 3.93 | 3.87 | 3.81 | 3.75 | 3.70 | 3.64 | 3.58 | 3.52 | 3.46 | 3.41 | 3.35 | 3.29 | 3.23 | 3.17 | 3.12 | 3.06 |
| 63.5 | 3.88 | 4.04 | 4.19 | 4.35 | 4.30 | 4.24 | 4.18 | 4.13 | 4.07 | 4.01 | 3.95 | 3.89 | 3.84 | 3.78 | 3.72 | 3.66 | 3.60 | 3.55 | 3.49 | 3.43 | 3.37 | 3.31 | 3.26 | 3.20 | 3.14 |
| 64.0 | 3.95 | 4.10 | 4.26 | 4.41 | 4.38 | 4.32 | 4.27 | 4.21 | 4.15 | 4.09 | 4.03 | 3.98 | 3.92 | 3.86 | 3.80 | 3.74 | 3.69 | 3.63 | 3.57 | 3.51 | 3.45 | 3.40 | 3.34 | 3.28 | 3.22 |
| 64.5 | 4.01 | 4.17 | 4.32 | 4.48 | 4.46 | 4.41 | 4.35 | 4.29 | 4.23 | 4.17 | 4.12 | 4.06 | 4.00 | 3.94 | 3.88 | 3.83 | 3.77 | 3.71 | 3.65 | 3.59 | 3.54 | 3.48 | 3.42 | 3.36 | 3.30 |
| 65.0 | 4.07 | 4.23 | 4.39 | 4.54 | 4.55 | 4.49 | 4.43 | 4.37 | 4.32 | 4.26 | 4.20 | 4.14 | 4.08 | 4.03 | 3.97 | 3.91 | 3.85 | 3.79 | 3.74 | 3.68 | 3.62 | 3.56 | 3.50 | 3.45 | 3.39 |
| 65.5 | 4.14 | 4.29 | 4.45 | 4.60 | 4.63 | 4.57 | 4.51 | 4.46 | 4.40 | 4.34 | 4.28 | 4.22 | 4.17 | 4.11 | 4.05 | 3.99 | 3.93 | 3.88 | 3.82 | 3.76 | 3.70 | 3.64 | 3.59 | 3.53 | 3.47 |
| 66.0 | 4.20 | 4.36 | 4.51 | 4.67 | 4.71 | 4.65 | 4.60 | 4.54 | 4.48 | 4.42 | 4.36 | 4.31 | 4.25 | 4.19 | 4.13 | 4.07 | 4.02 | 3.96 | 3.90 | 3.84 | 3.78 | 3.73 | 3.67 | 3.61 | 3.55 |
| 66.5 | 4.26 | 4.42 | 4.58 | 4.73 | 4.80 | 4.74 | 4.68 | 4.62 | 4.56 | 4.51 | 4.45 | 4.39 | 4.33 | 4.27 | 4.22 | 4.16 | 4.10 | 4.04 | 3.98 | 3.93 | 3.87 | 3.81 | 3.75 | 3.69 | 3.64 |
| 67.0 | 4.33 | 4.48 | 4.64 | 4.80 | 4.88 | 4.82 | 4.76 | 4.70 | 4.65 | 4.59 | 4.53 | 4.47 | 4.41 | 4.36 | 4.30 | 4.24 | 4.18 | 4.12 | 4.07 | 4.01 | 3.95 | 3.89 | 3.83 | 3.78 | 3.72 |
| 67.5 | 4.39 | 4.55 | 4.70 | 4.86 | 4.96 | 4.90 | 4.84 | 4.79 | 4.73 | 4.67 | 4.61 | 4.55 | 4.50 | 4.44 | 4.38 | 4.32 | 4.26 | 4.21 | 4.15 | 4.09 | 4.03 | 3.97 | 3.92 | 3.86 | 3.80 |
| 68.0 | 4.45 | 4.61 | 4.77 | 4.92 | 5.04 | 4.98 | 4.93 | 4.87 | 4.81 | 4.75 | 4.69 | 4.64 | 4.58 | 4.52 | 4.46 | 4.40 | 4.35 | 4.29 | 4.23 | 4.17 | 4.11 | 4.06 | 4.00 | 3.94 | 3.88 |
| 68.5 | 4.52 | 4.67 | 4.83 | 4.99 | 5.13 | 5.07 | 5.01 | 4.95 | 4.89 | 4.84 | 4.78 | 4.72 | 4.66 | 4.60 | 4.55 | 4.49 | 4.43 | 4.37 | 4.31 | 4.26 | 4.20 | 4.14 | 4.08 | 4.02 | 3.97 |
| 69.0 | 4.58 | 4.74 | 4.89 | 5.05 | 5.21 | 5.15 | 5.09 | 5.03 | 4.98 | 4.92 | 4.86 | 4.80 | 4.74 | 4.69 | 4.63 | 4.57 | 4.51 | 4.45 | 4.40 | 4.34 | 4.28 | 4.22 | 4.16 | 4.11 | 4.05 |
| 69.5 | 4.64 | 4.80 | 4.96 | 5.11 | 5.29 | 5.23 | 5.17 | 5.12 | 5.06 | 5.00 | 4.94 | 4.88 | 4.83 | 4.77 | 4.71 | 4.65 | 4.59 | 4.54 | 4.48 | 4.42 | 4.36 | 4.30 | 4.25 | 4.19 | 4.13 |
| 70.0 | 4.71 | 4.86 | 5.02 | 5.18 | 5.37 | 5.32 | 5.26 | 5.20 | 5.14 | 5.08 | 5.02 | 4.97 | 4.91 | 4.85 | 4.79 | 4.74 | 4.68 | 4.62 | 4.56 | 4.50 | 4.44 | 4.39 | 4.33 | 4.27 | 4.21 |
| 70.5 | 4.77 | 4.93 | 5.08 | 5.24 | 5.46 | 5.40 | 5.34 | 5.28 | 5.22 | 5.17 | 5.11 | 5.05 | 4.99 | 4.93 | 4.88 | 4.82 | 4.76 | 4.70 | 4.64 | 4.59 | 4.53 | 4.47 | 4.41 | 4.35 | 4.30 |
| 71.0 | 4.83 | 4.99 | 5.15 | 5.30 | 5.54 | 5.48 | 5.42 | 5.36 | 5.31 | 5.25 | 5.19 | 5.13 | 5.07 | 5.02 | 4.96 | 4.90 | 4.84 | 4.78 | 4.73 | 4.67 | 4.61 | 4.55 | 4.49 | 4.44 | 4.38 |
| 71.5 | 4.90 | 5.05 | 5.21 | 5.37 | 5.62 | 5.56 | 5.50 | 5.45 | 5.39 | 5.33 | 5.27 | 5.21 | 5.16 | 5.10 | 5.04 | 4.98 | 4.92 | 4.87 | 4.81 | 4.75 | 4.69 | 4.63 | 4.58 | 4.52 | 4.46 |
| 72.0 | 4.96 | 5.12 | 5.27 | 5.43 | 5.70 | 5.65 | 5.59 | 5.53 | 5.47 | 5.41 | 5.36 | 5.30 | 5.24 | 5.18 | 5.12 | 5.07 | 5.01 | 4.95 | 4.89 | 4.83 | 4.78 | 4.72 | 4.66 | 4.60 | 4.54 |
| 72.5 | 5.03 | 5.18 | 5.34 | 5.49 | 5.79 | 5.73 | 5.67 | 5.61 | 5.55 | 5.50 | 5.44 | 5.38 | 5.32 | 5.26 | 5.21 | 5.15 | 5.09 | 5.03 | 4.97 | 4.92 | 4.86 | 4.80 | 4.74 | 4.68 | 4.63 |
| 73.0 | 5.09 | 5.24 | 5.40 | 5.56 | 5.87 | 5.81 | 5.75 | 5.69 | 5.64 | 5.58 | 5.52 | 5.46 | 5.40 | 5.35 | 5.29 | 5.23 | 5.17 | 5.11 | 5.06 | 5.00 | 4.94 | 4.88 | 4.82 | 4.77 | 4.71 |
| 73.5 | 5.15 | 5.31 | 5.46 | 5.62 | 5.95 | 5.89 | 5.83 | 5.78 | 5.72 | 5.66 | 5.60 | 5.54 | 5.49 | 5.43 | 5.37 | 5.31 | 5.25 | 5.20 | 5.14 | 5.08 | 5.02 | 4.96 | 4.91 | 4.85 | 4.79 |
| 74.0 | 5.22 | 5.37 | 5.53 | 5.68 | 6.03 | 5.98 | 5.92 | 5.86 | 5.80 | 5.74 | 5.69 | 5.63 | 5.57 | 5.51 | 5.45 | 5.40 | 5.34 | 5.28 | 5.22 | 5.16 | 5.11 | 5.05 | 4.99 | 4.93 | 4.87 |
| 74.5 | 5.28 | 5.44 | 5.59 | 5.75 | 6.12 | 6.06 | 6.00 | 5.94 | 5.88 | 5.83 | 5.77 | 5.71 | 5.65 | 5.59 | 5.54 | 5.48 | 5.42 | 5.36 | 5.30 | 5.25 | 5.19 | 5.13 | 5.07 | 5.01 | 4.96 |
| 75.0 | 5.34 | 5.50 | 5.65 | 5.81 | 6.20 | 6.14 | 6.08 | 6.02 | 5.97 | 5.91 | 5.85 | 5.79 | 5.73 | 5.68 | 5.62 | 5.56 | 5.50 | 5.44 | 5.39 | 5.33 | 5.27 | 5.21 | 5.15 | 5.10 | 5.04 |
| 75.5 | 5.41 | 5.56 | 5.72 | 5.87 | 6.28 | 6.22 | 6.17 | 6.11 | 6.05 | 5.99 | 5.93 | 5.88 | 5.82 | 5.76 | 5.70 | 5.64 | 5.59 | 5.53 | 5.47 | 5.41 | 5.35 | 5.30 | 5.24 | 5.18 | 5.12 |
| 76.0 | 5.47 | 5.63 | 5.78 | 5.94 | 6.36 | 6.31 | 6.25 | 6.19 | 6.13 | 6.07 | 6.02 | 5.96 | 5.90 | 5.84 | 5.78 | 5.73 | 5.67 | 5.61 | 5.55 | 5.49 | 5.44 | 5.38 | 5.32 | 5.26 | 5.20 |
| 76.5 | 5.53 | 5.69 | 5.85 | 6.00 | 6.45 | 6.39 | 6.33 | 6.27 | 6.21 | 6.16 | 6.10 | 6.04 | 5.98 | 5.92 | 5.87 | 5.81 | 5.75 | 5.69 | 5.63 | 5.58 | 5.52 | 5.46 | 5.40 | 5.34 | 5.29 |
| 77.0 | 5.60 | 5.75 | 5.91 | 6.06 | 6.53 | 6.47 | 6.41 | 6.35 | 6.30 | 6.24 | 6.18 | 6.12 | 6.06 | 6.01 | 5.95 | 5.89 | 5.83 | 5.77 | 5.72 | 5.66 | 5.60 | 5.54 | 5.48 | 5.43 | 5.37 |
| 77.5 | 5.66 | 5.82 | 5.97 | 6.13 | 6.61 | 6.55 | 6.50 | 6.44 | 6.38 | 6.32 | 6.26 | 6.21 | 6.15 | 6.09 | 6.03 | 5.97 | 5.92 | 5.86 | 5.80 | 5.74 | 5.68 | 5.63 | 5.57 | 5.51 | 5.45 |
| 78.0 | 5.72 | 5.88 | 6.04 | 6.19 | 6.69 | 6.64 | 6.58 | 6.52 | 6.46 | 6.40 | 6.35 | 6.29 | 6.23 | 6.17 | 6.11 | 6.06 | 6.00 | 5.94 | 5.88 | 5.82 | 5.77 | 5.71 | 5.65 | 5.59 | 5.53 |
| 78.5 | 5.79 | 5.94 | 6.10 | 6.26 | 6.78 | 6.72 | 6.66 | 6.60 | 6.54 | 6.49 | 6.43 | 6.37 | 6.31 | 6.25 | 6.20 | 6.14 | 6.08 | 6.02 | 5.96 | 5.91 | 5.85 | 5.79 | 5.73 | 5.67 | 5.62 |
| 79.0 | 5.85 | 6.01 | 6.16 | 6.32 | 6.86 | 6.80 | 6.74 | 6.68 | 6.63 | 6.57 | 6.51 | 6.45 | 6.39 | 6.34 | 6.28 | 6.22 | 6.16 | 6.10 | 6.05 | 5.99 | 5.93 | 5.87 | 5.81 | 5.76 | 5.70 |
| 79.5 | 5.91 | 6.07 | 6.23 | 6.38 | 6.94 | 6.88 | 6.83 | 6.77 | 6.71 | 6.65 | 6.59 | 6.54 | 6.48 | 6.42 | 6.36 | 6.30 | 6.25 | 6.19 | 6.13 | 6.07 | 6.01 | 5.96 | 5.90 | 5.84 | 5.78 |
| 80.0 | 5.98 | 6.13 | 6.29 | 6.45 | 7.02 | 6.97 | 6.91 | 6.85 | 6.79 | 6.73 | 6.68 | 6.62 | 6.56 | 6.50 | 6.44 | 6.39 | 6.33 | 6.27 | 6.21 | 6.15 | 6.10 | 6.04 | 5.98 | 5.92 | 5.86 |
| 80.5 | 6.04 | 6.20 | 6.35 | 6.51 | 7.11 | 7.05 | 6.99 | 6.93 | 6.87 | 6.82 | 6.76 | 6.70 | 6.64 | 6.58 | 6.53 | 6.47 | 6.41 | 6.35 | 6.29 | 6.24 | 6.18 | 6.12 | 6.06 | 6.00 | 5.95 |
| 81.0 | 6.10 | 6.26 | 6.42 | 6.57 | 7.19 | 7.13 | 7.07 | 7.02 | 6.96 | 6.90 | 6.84 | 6.78 | 6.73 | 6.67 | 6.61 | 6.55 | 6.49 | 6.44 | 6.38 | 6.32 | 6.26 | 6.20 | 6.15 | 6.09 | 6.03 |
| 81.5 | 6.17 | 6.32 | 6.48 | 6.64 | 7.27 | 7.21 | 7.16 | 7.10 | 7.04 | 6.98 | 6.92 | 6.87 | 6.81 | 6.75 | 6.69 | 6.63 | 6.58 | 6.52 | 6.46 | 6.40 | 6.34 | 6.29 | 6.23 | 6.17 | 6.11 |
| 82.0 | 6.23 | 6.39 | 6.54 | 6.70 | 7.35 | 7.30 | 7.24 | 7.18 | 7.12 | 7.06 | 7.01 | 6.95 | 6.89 | 6.83 | 6.77 | 6.72 | 6.66 | 6.60 | 6.54 | 6.48 | 6.43 | 6.37 | 6.31 | 6.25 | 6.19 |
| 82.5 | 6.30 | 6.45 | 6.61 | 6.76 | 7.44 | 7.38 | 7.32 | 7.26 | 7.20 | 7.15 | 7.09 | 7.03 | 6.97 | 6.91 | 6.86 | 6.80 | 6.74 | 6.68 | 6.62 | 6.57 | 6.51 | 6.45 | 6.39 | 6.33 | 6.28 |
| 83.0 | 6.36 | 6.51 | 6.67 | 6.83 | 7.52 | 7.46 | 7.40 | 7.35 | 7.29 | 7.23 | 7.17 | 7.11 | 7.06 | 7.00 | 6.94 | 6.88 | 6.82 | 6.77 | 6.71 | 6.65 | 6.59 | 6.53 | 6.48 | 6.42 | 6.36 |
| 83.5 | 6.42 | 6.58 | 6.73 | 6.89 | 7.60 | 7.54 | 7.49 | 7.43 | 7.37 | 7.31 | 7.25 | 7.20 | 7.14 | 7.08 | 7.02 | 6.96 | 6.91 | 6.85 | 6.79 | 6.73 | 6.67 | 6.62 | 6.56 | 6.50 | 6.44 |
| 84.0 | 6.49 | 6.64 | 6.80 | 6.95 | 7.68 | 7.63 | 7.57 | 7.51 | 7.45 | 7.39 | 7.34 | 7.28 | 7.22 | 7.16 | 7.10 | 7.05 | 6.99 | 6.93 | 6.87 | 6.81 | 6.76 | 6.70 | 6.64 | 6.58 | 6.52 |
| 84.5 | 6.55 | 6.71 | 6.86 | 7.02 | 7.77 | 7.71 | 7.65 | 7.59 | 7.53 | 7.48 | 7.42 | 7.36 | 7.30 | 7.24 | 7.19 | 7.13 | 7.07 | 7.01 | 6.95 | 6.90 | 6.84 | 6.78 | 6.72 | 6.66 | 6.61 |
| 85.0 | 6.61 | 6.77 | 6.92 | 7.08 | 7.85 | 7.79 | 7.73 | 7.68 | 7.62 | 7.56 | 7.50 | 7.44 | 7.39 | 7.33 | 7.27 | 7.21 | 7.15 | 7.10 | 7.04 | 6.98 | 6.92 | 6.86 | 6.81 | 6.75 | 6.69 |

TABLE 2. PREDICTED FEV1 FOR MALES (HUDSON, ET AL: AM REV RESPIR DIS. 1976. 113. 587.)

| HT | AGE 17 | 19 | 21 | 23 | 25 | 27 | 29 | 31 | 33 | 35 | 37 | 39 | 41 | 43 | 45 | 47 | 49 | 51 | 53 | 55 | 57 | 59 | 61 | 63 | 65 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 60.0 | 2.97 | 3.06 | 3.15 | 3.24 | 3.05 | 2.99 | 2.94 | 2.88 | 2.83 | 2.78 | 2.72 | 2.67 | 2.61 | 2.56 | 2.51 | 2.45 | 2.40 | 2.34 | 2.29 | 2.24 | 2.18 | 2.13 | 2.07 | 2.02 | 1.97 |
| 60.5 | 3.03 | 3.12 | 3.21 | 3.30 | 3.11 | 3.06 | 3.00 | 2.95 | 2.90 | 2.84 | 2.79 | 2.73 | 2.68 | 2.63 | 2.57 | 2.52 | 2.46 | 2.41 | 2.36 | 2.30 | 2.25 | 2.19 | 2.14 | 2.09 | 2.03 |
| 61.0 | 3.08 | 3.17 | 3.26 | 3.35 | 3.18 | 3.12 | 3.07 | 3.02 | 2.96 | 2.91 | 2.85 | 2.80 | 2.75 | 2.69 | 2.64 | 2.58 | 2.53 | 2.48 | 2.42 | 2.37 | 2.31 | 2.26 | 2.21 | 2.15 | 2.10 |
| 61.5 | 3.14 | 3.23 | 3.32 | 3.41 | 3.24 | 3.19 | 3.14 | 3.08 | 3.03 | 2.97 | 2.92 | 2.87 | 2.81 | 2.76 | 2.70 | 2.65 | 2.60 | 2.54 | 2.49 | 2.43 | 2.38 | 2.33 | 2.27 | 2.22 | 2.16 |
| 62.0 | 3.20 | 3.29 | 3.38 | 3.47 | 3.31 | 3.26 | 3.20 | 3.15 | 3.09 | 3.04 | 2.99 | 2.93 | 2.88 | 2.82 | 2.77 | 2.72 | 2.66 | 2.61 | 2.55 | 2.50 | 2.45 | 2.39 | 2.34 | 2.28 | 2.23 |
| 62.5 | 3.26 | 3.35 | 3.44 | 3.53 | 3.38 | 3.32 | 3.27 | 3.22 | 3.16 | 3.11 | 3.05 | 3.00 | 2.95 | 2.89 | 2.84 | 2.78 | 2.73 | 2.68 | 2.62 | 2.57 | 2.51 | 2.46 | 2.41 | 2.35 | 2.30 |
| 63.0 | 3.32 | 3.41 | 3.50 | 3.59 | 3.44 | 3.39 | 3.34 | 3.28 | 3.23 | 3.17 | 3.12 | 3.07 | 3.01 | 2.96 | 2.90 | 2.85 | 2.80 | 2.74 | 2.69 | 2.63 | 2.58 | 2.53 | 2.47 | 2.42 | 2.36 |
| 63.5 | 3.38 | 3.47 | 3.56 | 3.65 | 3.51 | 3.46 | 3.40 | 3.35 | 3.29 | 3.24 | 3.19 | 3.13 | 3.08 | 3.02 | 2.97 | 2.92 | 2.86 | 2.81 | 2.75 | 2.70 | 2.65 | 2.59 | 2.54 | 2.48 | 2.43 |
| 64.0 | 3.43 | 3.52 | 3.61 | 3.70 | 3.58 | 3.52 | 3.47 | 3.41 | 3.36 | 3.31 | 3.25 | 3.20 | 3.14 | 3.09 | 3.04 | 2.98 | 2.93 | 2.87 | 2.82 | 2.77 | 2.71 | 2.66 | 2.60 | 2.55 | 2.50 |
| 64.5 | 3.49 | 3.58 | 3.67 | 3.76 | 3.64 | 3.59 | 3.53 | 3.48 | 3.43 | 3.37 | 3.32 | 3.26 | 3.21 | 3.16 | 3.10 | 3.05 | 2.99 | 2.94 | 2.89 | 2.83 | 2.78 | 2.72 | 2.67 | 2.62 | 2.56 |
| 65.0 | 3.55 | 3.64 | 3.73 | 3.82 | 3.71 | 3.65 | 3.60 | 3.55 | 3.49 | 3.44 | 3.38 | 3.33 | 3.28 | 3.22 | 3.17 | 3.11 | 3.06 | 3.01 | 2.95 | 2.90 | 2.84 | 2.79 | 2.74 | 2.68 | 2.63 |
| 65.5 | 3.61 | 3.70 | 3.79 | 3.88 | 3.77 | 3.72 | 3.67 | 3.61 | 3.56 | 3.50 | 3.45 | 3.40 | 3.34 | 3.29 | 3.23 | 3.18 | 3.13 | 3.07 | 3.02 | 2.96 | 2.91 | 2.86 | 2.80 | 2.75 | 2.69 |
| 66.0 | 3.67 | 3.76 | 3.85 | 3.94 | 3.84 | 3.79 | 3.73 | 3.68 | 3.62 | 3.57 | 3.52 | 3.46 | 3.41 | 3.35 | 3.30 | 3.25 | 3.19 | 3.14 | 3.08 | 3.03 | 2.98 | 2.92 | 2.87 | 2.81 | 2.76 |
| 66.5 | 3.73 | 3.82 | 3.91 | 4.00 | 3.91 | 3.85 | 3.80 | 3.74 | 3.69 | 3.64 | 3.58 | 3.53 | 3.47 | 3.42 | 3.37 | 3.31 | 3.26 | 3.20 | 3.15 | 3.10 | 3.04 | 2.99 | 2.93 | 2.88 | 2.83 |
| 67.0 | 3.79 | 3.88 | 3.97 | 4.06 | 3.97 | 3.92 | 3.86 | 3.81 | 3.76 | 3.70 | 3.65 | 3.59 | 3.54 | 3.49 | 3.43 | 3.38 | 3.32 | 3.27 | 3.22 | 3.16 | 3.11 | 3.05 | 3.00 | 2.95 | 2.89 |
| 67.5 | 3.84 | 3.93 | 4.02 | 4.11 | 4.04 | 3.98 | 3.93 | 3.88 | 3.82 | 3.77 | 3.71 | 3.66 | 3.61 | 3.55 | 3.50 | 3.44 | 3.39 | 3.34 | 3.28 | 3.23 | 3.17 | 3.12 | 3.07 | 3.01 | 2.96 |
| 68.0 | 3.90 | 3.99 | 4.08 | 4.17 | 4.10 | 4.05 | 4.00 | 3.94 | 3.89 | 3.83 | 3.78 | 3.73 | 3.67 | 3.62 | 3.56 | 3.51 | 3.46 | 3.40 | 3.35 | 3.29 | 3.24 | 3.19 | 3.13 | 3.08 | 3.02 |
| 68.5 | 3.96 | 4.05 | 4.14 | 4.23 | 4.17 | 4.12 | 4.06 | 4.01 | 3.95 | 3.90 | 3.85 | 3.79 | 3.74 | 3.68 | 3.63 | 3.58 | 3.52 | 3.47 | 3.41 | 3.36 | 3.31 | 3.25 | 3.20 | 3.14 | 3.09 |
| 69.0 | 4.02 | 4.11 | 4.20 | 4.29 | 4.24 | 4.18 | 4.13 | 4.07 | 4.02 | 3.97 | 3.91 | 3.86 | 3.80 | 3.75 | 3.70 | 3.64 | 3.59 | 3.53 | 3.48 | 3.43 | 3.37 | 3.32 | 3.26 | 3.21 | 3.16 |
| 69.5 | 4.08 | 4.17 | 4.26 | 4.35 | 4.30 | 4.25 | 4.19 | 4.14 | 4.09 | 4.03 | 3.98 | 3.92 | 3.87 | 3.82 | 3.76 | 3.71 | 3.65 | 3.60 | 3.55 | 3.49 | 3.44 | 3.38 | 3.33 | 3.28 | 3.22 |
| 70.0 | 4.14 | 4.23 | 4.32 | 4.41 | 4.37 | 4.31 | 4.26 | 4.21 | 4.15 | 4.10 | 4.04 | 3.99 | 3.94 | 3.88 | 3.83 | 3.77 | 3.72 | 3.67 | 3.61 | 3.56 | 3.50 | 3.45 | 3.40 | 3.34 | 3.29 |
| 70.5 | 4.19 | 4.28 | 4.37 | 4.46 | 4.43 | 4.38 | 4.33 | 4.27 | 4.22 | 4.16 | 4.11 | 4.06 | 4.00 | 3.95 | 3.89 | 3.84 | 3.79 | 3.73 | 3.68 | 3.62 | 3.57 | 3.52 | 3.46 | 3.41 | 3.35 |
| 71.0 | 4.25 | 4.34 | 4.43 | 4.52 | 4.50 | 4.45 | 4.39 | 4.34 | 4.28 | 4.23 | 4.18 | 4.12 | 4.07 | 4.01 | 3.96 | 3.91 | 3.85 | 3.80 | 3.74 | 3.69 | 3.64 | 3.58 | 3.53 | 3.47 | 3.42 |
| 71.5 | 4.31 | 4.40 | 4.49 | 4.58 | 4.57 | 4.51 | 4.46 | 4.40 | 4.35 | 4.30 | 4.24 | 4.19 | 4.13 | 4.08 | 4.03 | 3.97 | 3.92 | 3.86 | 3.81 | 3.76 | 3.70 | 3.65 | 3.59 | 3.54 | 3.49 |
| 72.0 | 4.37 | 4.46 | 4.55 | 4.64 | 4.63 | 4.58 | 4.52 | 4.47 | 4.42 | 4.36 | 4.31 | 4.25 | 4.20 | 4.15 | 4.09 | 4.04 | 3.98 | 3.93 | 3.88 | 3.82 | 3.77 | 3.71 | 3.66 | 3.61 | 3.55 |
| 72.5 | 4.43 | 4.52 | 4.61 | 4.70 | 4.70 | 4.64 | 4.59 | 4.54 | 4.48 | 4.43 | 4.37 | 4.32 | 4.27 | 4.21 | 4.16 | 4.10 | 4.05 | 4.00 | 3.94 | 3.89 | 3.83 | 3.78 | 3.73 | 3.67 | 3.62 |
| 73.0 | 4.49 | 4.58 | 4.67 | 4.76 | 4.76 | 4.71 | 4.66 | 4.60 | 4.55 | 4.49 | 4.44 | 4.39 | 4.33 | 4.28 | 4.22 | 4.17 | 4.12 | 4.06 | 4.01 | 3.95 | 3.90 | 3.85 | 3.79 | 3.74 | 3.68 |
| 73.5 | 4.54 | 4.63 | 4.72 | 4.81 | 4.83 | 4.78 | 4.72 | 4.67 | 4.61 | 4.56 | 4.51 | 4.45 | 4.40 | 4.34 | 4.29 | 4.24 | 4.18 | 4.13 | 4.07 | 4.02 | 3.97 | 3.91 | 3.86 | 3.80 | 3.75 |
| 74.0 | 4.60 | 4.69 | 4.78 | 4.87 | 4.90 | 4.84 | 4.79 | 4.73 | 4.68 | 4.63 | 4.57 | 4.52 | 4.46 | 4.41 | 4.36 | 4.30 | 4.25 | 4.19 | 4.14 | 4.09 | 4.03 | 3.98 | 3.92 | 3.87 | 3.82 |
| 74.5 | 4.66 | 4.75 | 4.84 | 4.93 | 4.96 | 4.91 | 4.85 | 4.80 | 4.75 | 4.69 | 4.64 | 4.58 | 4.53 | 4.48 | 4.42 | 4.37 | 4.31 | 4.26 | 4.21 | 4.15 | 4.10 | 4.04 | 3.99 | 3.94 | 3.88 |
| 75.0 | 4.72 | 4.81 | 4.90 | 4.99 | 5.03 | 4.97 | 4.92 | 4.87 | 4.81 | 4.76 | 4.70 | 4.65 | 4.60 | 4.54 | 4.49 | 4.43 | 4.38 | 4.33 | 4.27 | 4.22 | 4.16 | 4.11 | 4.06 | 4.00 | 3.95 |
| 75.5 | 4.78 | 4.87 | 4.96 | 5.05 | 5.09 | 5.04 | 4.99 | 4.93 | 4.88 | 4.82 | 4.77 | 4.72 | 4.66 | 4.61 | 4.55 | 4.50 | 4.45 | 4.39 | 4.34 | 4.28 | 4.23 | 4.18 | 4.12 | 4.07 | 4.01 |
| 76.0 | 4.84 | 4.93 | 5.02 | 5.11 | 5.16 | 5.11 | 5.05 | 5.00 | 4.94 | 4.89 | 4.84 | 4.78 | 4.73 | 4.67 | 4.62 | 4.57 | 4.51 | 4.46 | 4.40 | 4.35 | 4.30 | 4.24 | 4.19 | 4.13 | 4.08 |
| 76.5 | 4.90 | 4.99 | 5.08 | 5.17 | 5.23 | 5.17 | 5.12 | 5.06 | 5.01 | 4.96 | 4.90 | 4.85 | 4.79 | 4.74 | 4.69 | 4.63 | 4.58 | 4.52 | 4.47 | 4.42 | 4.36 | 4.31 | 4.25 | 4.20 | 4.15 |
| 77.0 | 4.95 | 5.04 | 5.13 | 5.22 | 5.29 | 5.24 | 5.18 | 5.13 | 5.08 | 5.02 | 4.97 | 4.91 | 4.86 | 4.81 | 4.75 | 4.70 | 4.64 | 4.59 | 4.54 | 4.48 | 4.43 | 4.37 | 4.32 | 4.27 | 4.21 |
| 77.5 | 5.01 | 5.10 | 5.19 | 5.28 | 5.36 | 5.30 | 5.25 | 5.20 | 5.14 | 5.09 | 5.03 | 4.98 | 4.93 | 4.87 | 4.82 | 4.76 | 4.71 | 4.66 | 4.60 | 4.55 | 4.49 | 4.44 | 4.39 | 4.33 | 4.28 |
| 78.0 | 5.07 | 5.16 | 5.25 | 5.34 | 5.42 | 5.37 | 5.32 | 5.26 | 5.21 | 5.15 | 5.10 | 5.05 | 4.99 | 4.94 | 4.88 | 4.83 | 4.78 | 4.72 | 4.67 | 4.61 | 4.56 | 4.51 | 4.45 | 4.40 | 4.34 |
| 78.5 | 5.13 | 5.22 | 5.31 | 5.40 | 5.49 | 5.44 | 5.38 | 5.33 | 5.27 | 5.22 | 5.17 | 5.11 | 5.06 | 5.00 | 4.95 | 4.90 | 4.84 | 4.79 | 4.73 | 4.68 | 4.63 | 4.57 | 4.52 | 4.46 | 4.41 |
| 79.0 | 5.19 | 5.28 | 5.37 | 5.46 | 5.56 | 5.50 | 5.45 | 5.39 | 5.34 | 5.29 | 5.23 | 5.18 | 5.12 | 5.07 | 5.02 | 4.96 | 4.91 | 4.85 | 4.80 | 4.75 | 4.69 | 4.64 | 4.58 | 4.53 | 4.48 |
| 79.5 | 5.25 | 5.34 | 5.43 | 5.52 | 5.62 | 5.57 | 5.51 | 5.46 | 5.41 | 5.35 | 5.30 | 5.24 | 5.19 | 5.14 | 5.08 | 5.03 | 4.97 | 4.92 | 4.87 | 4.81 | 4.76 | 4.70 | 4.65 | 4.60 | 4.54 |
| 80.0 | 5.30 | 5.39 | 5.48 | 5.57 | 5.69 | 5.63 | 5.58 | 5.53 | 5.47 | 5.42 | 5.36 | 5.31 | 5.26 | 5.20 | 5.15 | 5.09 | 5.04 | 4.99 | 4.93 | 4.88 | 4.82 | 4.77 | 4.72 | 4.66 | 4.61 |
| 80.5 | 5.36 | 5.45 | 5.54 | 5.63 | 5.75 | 5.70 | 5.65 | 5.59 | 5.54 | 5.48 | 5.43 | 5.38 | 5.32 | 5.27 | 5.21 | 5.16 | 5.11 | 5.05 | 5.00 | 4.94 | 4.89 | 4.84 | 4.78 | 4.73 | 4.67 |
| 81.0 | 5.42 | 5.51 | 5.60 | 5.69 | 5.82 | 5.77 | 5.71 | 5.66 | 5.60 | 5.55 | 5.50 | 5.44 | 5.39 | 5.33 | 5.28 | 5.23 | 5.17 | 5.12 | 5.06 | 5.01 | 4.96 | 4.90 | 4.85 | 4.79 | 4.74 |
| 81.5 | 5.48 | 5.57 | 5.66 | 5.75 | 5.89 | 5.83 | 5.78 | 5.72 | 5.67 | 5.62 | 5.56 | 5.51 | 5.45 | 5.40 | 5.35 | 5.29 | 5.24 | 5.18 | 5.13 | 5.08 | 5.02 | 4.97 | 4.91 | 4.86 | 4.81 |
| 82.0 | 5.54 | 5.63 | 5.72 | 5.81 | 5.95 | 5.90 | 5.84 | 5.79 | 5.74 | 5.68 | 5.63 | 5.57 | 5.52 | 5.47 | 5.41 | 5.36 | 5.30 | 5.25 | 5.20 | 5.14 | 5.09 | 5.03 | 4.98 | 4.93 | 4.87 |
| 82.5 | 5.60 | 5.69 | 5.78 | 5.87 | 6.02 | 5.96 | 5.91 | 5.86 | 5.80 | 5.75 | 5.69 | 5.64 | 5.59 | 5.53 | 5.48 | 5.42 | 5.37 | 5.32 | 5.26 | 5.21 | 5.15 | 5.10 | 5.05 | 4.99 | 4.94 |
| 83.0 | 5.65 | 5.74 | 5.83 | 5.92 | 6.08 | 6.03 | 5.98 | 5.92 | 5.87 | 5.81 | 5.76 | 5.71 | 5.65 | 5.60 | 5.54 | 5.49 | 5.44 | 5.38 | 5.33 | 5.27 | 5.22 | 5.17 | 5.11 | 5.06 | 5.00 |
| 83.5 | 5.71 | 5.80 | 5.89 | 5.98 | 6.15 | 6.10 | 6.04 | 5.99 | 5.93 | 5.88 | 5.83 | 5.77 | 5.72 | 5.66 | 5.61 | 5.56 | 5.50 | 5.45 | 5.39 | 5.34 | 5.29 | 5.23 | 5.18 | 5.12 | 5.07 |
| 84.0 | 5.77 | 5.86 | 5.95 | 6.04 | 6.22 | 6.16 | 6.11 | 6.05 | 6.00 | 5.95 | 5.89 | 5.84 | 5.78 | 5.73 | 5.68 | 5.62 | 5.57 | 5.51 | 5.46 | 5.41 | 5.35 | 5.30 | 5.24 | 5.19 | 5.14 |
| 84.5 | 5.83 | 5.92 | 6.01 | 6.10 | 6.28 | 6.23 | 6.17 | 6.12 | 6.07 | 6.01 | 5.96 | 5.90 | 5.85 | 5.80 | 5.74 | 5.69 | 5.63 | 5.58 | 5.53 | 5.47 | 5.42 | 5.36 | 5.31 | 5.26 | 5.20 |
| 85.0 | 5.89 | 5.98 | 6.07 | 6.16 | 6.35 | 6.29 | 6.24 | 6.19 | 6.13 | 6.08 | 6.02 | 5.97 | 5.92 | 5.86 | 5.81 | 5.75 | 5.70 | 5.65 | 5.59 | 5.54 | 5.48 | 5.43 | 5.38 | 5.32 | 5.27 |

TABLE 3. PREDICTED FVC FOR FEMALES (HUDSON, ET AL.: AM REV RESPIR DIS. 1976, 113, 587.)

| HT | AGE 17 | 19 | 21 | 23 | 25 | 27 | 29 | 31 | 33 | 35 | 37 | 39 | 41 | 43 | 45 | 47 | 49 | 51 | 53 | 55 | 57 | 59 | 61 | 63 | 65 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 52.0 | 2.45 | 2.64 | 2.65 | 2.61 | 2.56 | 2.52 | 2.47 | 2.43 | 2.39 | 2.34 | 2.30 | 2.25 | 2.21 | 2.17 | 2.12 | 2.08 | 2.03 | 1.99 | 1.95 | 1.90 | 1.86 | 1.81 | 1.77 | 1.73 | 1.68 |
| 52.5 | 2.50 | 2.68 | 2.70 | 2.65 | 2.61 | 2.57 | 2.52 | 2.48 | 2.43 | 2.39 | 2.35 | 2.30 | 2.26 | 2.21 | 2.17 | 2.13 | 2.08 | 2.04 | 1.99 | 1.95 | 1.91 | 1.86 | 1.82 | 1.77 | 1.73 |
| 53.0 | 2.54 | 2.72 | 2.74 | 2.70 | 2.66 | 2.61 | 2.57 | 2.52 | 2.48 | 2.44 | 2.39 | 2.35 | 2.30 | 2.26 | 2.22 | 2.17 | 2.13 | 2.08 | 2.04 | 2.00 | 1.95 | 1.91 | 1.86 | 1.82 | 1.78 |
| 53.5 | 2.58 | 2.76 | 2.79 | 2.75 | 2.70 | 2.66 | 2.62 | 2.57 | 2.53 | 2.48 | 2.44 | 2.40 | 2.35 | 2.31 | 2.26 | 2.22 | 2.18 | 2.13 | 2.09 | 2.04 | 2.00 | 1.96 | 1.91 | 1.87 | 1.82 |
| 54.0 | 2.62 | 2.81 | 2.84 | 2.79 | 2.75 | 2.71 | 2.66 | 2.62 | 2.57 | 2.53 | 2.49 | 2.44 | 2.40 | 2.35 | 2.31 | 2.27 | 2.22 | 2.18 | 2.13 | 2.09 | 2.05 | 2.00 | 1.96 | 1.91 | 1.87 |
| 54.5 | 2.66 | 2.85 | 2.89 | 2.84 | 2.80 | 2.75 | 2.71 | 2.67 | 2.62 | 2.58 | 2.53 | 2.49 | 2.45 | 2.40 | 2.36 | 2.31 | 2.27 | 2.23 | 2.18 | 2.14 | 2.09 | 2.05 | 2.01 | 1.96 | 1.92 |
| 55.0 | 2.71 | 2.89 | 2.93 | 2.89 | 2.84 | 2.80 | 2.76 | 2.71 | 2.67 | 2.62 | 2.58 | 2.54 | 2.49 | 2.45 | 2.40 | 2.36 | 2.32 | 2.27 | 2.23 | 2.18 | 2.14 | 2.10 | 2.05 | 2.01 | 1.96 |
| 55.5 | 2.75 | 2.93 | 2.98 | 2.94 | 2.89 | 2.85 | 2.80 | 2.76 | 2.72 | 2.67 | 2.63 | 2.58 | 2.54 | 2.50 | 2.45 | 2.41 | 2.36 | 2.32 | 2.28 | 2.23 | 2.19 | 2.14 | 2.10 | 2.06 | 2.01 |
| 56.0 | 2.79 | 2.97 | 3.03 | 2.98 | 2.94 | 2.89 | 2.85 | 2.81 | 2.76 | 2.72 | 2.67 | 2.63 | 2.59 | 2.54 | 2.50 | 2.45 | 2.41 | 2.37 | 2.32 | 2.28 | 2.23 | 2.19 | 2.15 | 2.10 | 2.06 |
| 56.5 | 2.83 | 3.01 | 3.07 | 3.03 | 2.99 | 2.94 | 2.90 | 2.85 | 2.81 | 2.77 | 2.72 | 2.68 | 2.63 | 2.59 | 2.55 | 2.50 | 2.46 | 2.41 | 2.37 | 2.33 | 2.28 | 2.24 | 2.19 | 2.15 | 2.11 |
| 57.0 | 2.87 | 3.06 | 3.12 | 3.08 | 3.03 | 2.99 | 2.94 | 2.90 | 2.86 | 2.81 | 2.77 | 2.72 | 2.68 | 2.64 | 2.59 | 2.55 | 2.50 | 2.46 | 2.42 | 2.37 | 2.33 | 2.28 | 2.24 | 2.20 | 2.15 |
| 57.5 | 2.91 | 3.10 | 3.17 | 3.12 | 3.08 | 3.04 | 2.99 | 2.95 | 2.90 | 2.86 | 2.82 | 2.77 | 2.73 | 2.68 | 2.64 | 2.60 | 2.55 | 2.51 | 2.46 | 2.42 | 2.38 | 2.33 | 2.29 | 2.24 | 2.20 |
| 58.0 | 2.96 | 3.14 | 3.21 | 3.17 | 3.13 | 3.08 | 3.04 | 2.99 | 2.95 | 2.91 | 2.86 | 2.82 | 2.77 | 2.73 | 2.69 | 2.64 | 2.60 | 2.55 | 2.51 | 2.47 | 2.42 | 2.38 | 2.33 | 2.29 | 2.25 |
| 58.5 | 3.00 | 3.18 | 3.26 | 3.22 | 3.17 | 3.13 | 3.09 | 3.04 | 3.00 | 2.95 | 2.91 | 2.87 | 2.82 | 2.78 | 2.73 | 2.69 | 2.65 | 2.60 | 2.56 | 2.51 | 2.47 | 2.43 | 2.38 | 2.34 | 2.29 |
| 59.0 | 3.04 | 3.22 | 3.31 | 3.26 | 3.22 | 3.18 | 3.13 | 3.09 | 3.04 | 3.00 | 2.96 | 2.91 | 2.87 | 2.82 | 2.78 | 2.74 | 2.69 | 2.65 | 2.60 | 2.56 | 2.52 | 2.47 | 2.43 | 2.38 | 2.34 |
| 59.5 | 3.08 | 3.27 | 3.36 | 3.31 | 3.27 | 3.23 | 3.18 | 3.14 | 3.09 | 3.05 | 3.00 | 2.96 | 2.92 | 2.87 | 2.83 | 2.78 | 2.74 | 2.70 | 2.65 | 2.61 | 2.56 | 2.52 | 2.48 | 2.43 | 2.39 |
| 60.0 | 3.12 | 3.31 | 3.40 | 3.36 | 3.31 | 3.27 | 3.23 | 3.18 | 3.14 | 3.09 | 3.05 | 3.01 | 2.96 | 2.92 | 2.87 | 2.83 | 2.79 | 2.74 | 2.70 | 2.65 | 2.61 | 2.57 | 2.52 | 2.48 | 2.43 |
| 60.5 | 3.17 | 3.35 | 3.45 | 3.41 | 3.36 | 3.32 | 3.27 | 3.23 | 3.19 | 3.14 | 3.10 | 3.05 | 3.01 | 2.97 | 2.92 | 2.88 | 2.83 | 2.79 | 2.75 | 2.70 | 2.66 | 2.61 | 2.57 | 2.53 | 2.48 |
| 61.0 | 3.21 | 3.39 | 3.50 | 3.45 | 3.41 | 3.36 | 3.32 | 3.28 | 3.23 | 3.19 | 3.14 | 3.10 | 3.06 | 3.01 | 2.97 | 2.92 | 2.88 | 2.84 | 2.79 | 2.75 | 2.70 | 2.66 | 2.62 | 2.57 | 2.53 |
| 61.5 | 3.25 | 3.43 | 3.54 | 3.50 | 3.46 | 3.41 | 3.37 | 3.32 | 3.28 | 3.24 | 3.19 | 3.15 | 3.10 | 3.06 | 3.02 | 2.97 | 2.93 | 2.88 | 2.84 | 2.80 | 2.75 | 2.71 | 2.66 | 2.62 | 2.58 |
| 62.0 | 3.29 | 3.48 | 3.59 | 3.55 | 3.50 | 3.46 | 3.41 | 3.37 | 3.33 | 3.28 | 3.24 | 3.19 | 3.15 | 3.11 | 3.06 | 3.02 | 2.97 | 2.93 | 2.89 | 2.84 | 2.80 | 2.75 | 2.71 | 2.67 | 2.62 |
| 62.5 | 3.33 | 3.52 | 3.64 | 3.59 | 3.55 | 3.51 | 3.46 | 3.42 | 3.37 | 3.33 | 3.29 | 3.24 | 3.20 | 3.15 | 3.11 | 3.07 | 3.02 | 2.98 | 2.93 | 2.89 | 2.85 | 2.80 | 2.76 | 2.71 | 2.67 |
| 63.0 | 3.38 | 3.56 | 3.68 | 3.64 | 3.60 | 3.55 | 3.51 | 3.46 | 3.42 | 3.38 | 3.33 | 3.29 | 3.24 | 3.20 | 3.16 | 3.11 | 3.07 | 3.02 | 2.98 | 2.94 | 2.89 | 2.85 | 2.80 | 2.76 | 2.72 |
| 63.5 | 3.42 | 3.60 | 3.73 | 3.69 | 3.64 | 3.60 | 3.56 | 3.51 | 3.47 | 3.42 | 3.38 | 3.34 | 3.29 | 3.25 | 3.20 | 3.16 | 3.12 | 3.07 | 3.03 | 2.98 | 2.94 | 2.90 | 2.85 | 2.81 | 2.76 |
| 64.0 | 3.46 | 3.64 | 3.78 | 3.73 | 3.69 | 3.65 | 3.60 | 3.56 | 3.51 | 3.47 | 3.43 | 3.38 | 3.34 | 3.29 | 3.25 | 3.21 | 3.16 | 3.12 | 3.07 | 3.03 | 2.99 | 2.94 | 2.90 | 2.85 | 2.81 |
| 64.5 | 3.50 | 3.69 | 3.83 | 3.78 | 3.74 | 3.69 | 3.65 | 3.61 | 3.56 | 3.52 | 3.47 | 3.43 | 3.39 | 3.34 | 3.30 | 3.25 | 3.21 | 3.17 | 3.12 | 3.08 | 3.03 | 2.99 | 2.95 | 2.90 | 2.86 |
| 65.0 | 3.54 | 3.73 | 3.87 | 3.83 | 3.78 | 3.74 | 3.70 | 3.65 | 3.61 | 3.56 | 3.52 | 3.48 | 3.43 | 3.39 | 3.34 | 3.30 | 3.26 | 3.21 | 3.17 | 3.12 | 3.08 | 3.04 | 2.99 | 2.95 | 2.90 |
| 65.5 | 3.59 | 3.77 | 3.92 | 3.88 | 3.83 | 3.79 | 3.74 | 3.70 | 3.66 | 3.61 | 3.57 | 3.52 | 3.48 | 3.44 | 3.39 | 3.35 | 3.30 | 3.26 | 3.22 | 3.17 | 3.13 | 3.08 | 3.04 | 3.00 | 2.95 |
| 66.0 | 3.63 | 3.81 | 3.97 | 3.92 | 3.88 | 3.83 | 3.79 | 3.75 | 3.70 | 3.66 | 3.61 | 3.57 | 3.53 | 3.48 | 3.44 | 3.39 | 3.35 | 3.31 | 3.26 | 3.22 | 3.17 | 3.13 | 3.09 | 3.04 | 3.00 |
| 66.5 | 3.67 | 3.85 | 4.01 | 3.97 | 3.93 | 3.88 | 3.84 | 3.79 | 3.75 | 3.71 | 3.66 | 3.62 | 3.57 | 3.53 | 3.49 | 3.44 | 3.40 | 3.35 | 3.31 | 3.27 | 3.22 | 3.18 | 3.13 | 3.09 | 3.05 |
| 67.0 | 3.71 | 3.89 | 4.06 | 4.02 | 3.97 | 3.93 | 3.88 | 3.84 | 3.80 | 3.75 | 3.71 | 3.66 | 3.62 | 3.58 | 3.53 | 3.49 | 3.44 | 3.40 | 3.36 | 3.31 | 3.27 | 3.22 | 3.18 | 3.14 | 3.09 |
| 67.5 | 3.75 | 3.94 | 4.11 | 4.06 | 4.02 | 3.98 | 3.93 | 3.89 | 3.84 | 3.80 | 3.76 | 3.71 | 3.67 | 3.62 | 3.58 | 3.54 | 3.49 | 3.45 | 3.40 | 3.36 | 3.32 | 3.27 | 3.23 | 3.18 | 3.14 |
| 68.0 | 3.79 | 3.98 | 4.15 | 4.11 | 4.07 | 4.02 | 3.98 | 3.93 | 3.89 | 3.85 | 3.80 | 3.76 | 3.71 | 3.67 | 3.63 | 3.58 | 3.54 | 3.49 | 3.45 | 3.41 | 3.36 | 3.32 | 3.27 | 3.23 | 3.19 |
| 68.5 | 3.84 | 4.02 | 4.20 | 4.16 | 4.11 | 4.07 | 4.03 | 3.98 | 3.94 | 3.89 | 3.85 | 3.81 | 3.76 | 3.72 | 3.67 | 3.63 | 3.59 | 3.54 | 3.50 | 3.45 | 3.41 | 3.37 | 3.32 | 3.28 | 3.23 |
| 69.0 | 3.88 | 4.06 | 4.25 | 4.20 | 4.16 | 4.12 | 4.07 | 4.03 | 3.98 | 3.94 | 3.90 | 3.85 | 3.81 | 3.76 | 3.72 | 3.68 | 3.63 | 3.59 | 3.54 | 3.50 | 3.46 | 3.41 | 3.37 | 3.32 | 3.28 |
| 69.5 | 3.92 | 4.10 | 4.30 | 4.25 | 4.21 | 4.16 | 4.12 | 4.08 | 4.03 | 3.99 | 3.94 | 3.90 | 3.86 | 3.81 | 3.77 | 3.72 | 3.68 | 3.64 | 3.59 | 3.55 | 3.50 | 3.46 | 3.42 | 3.37 | 3.33 |
| 70.0 | 3.96 | 4.15 | 4.34 | 4.30 | 4.25 | 4.21 | 4.17 | 4.12 | 4.08 | 4.03 | 3.99 | 3.95 | 3.90 | 3.86 | 3.81 | 3.77 | 3.73 | 3.68 | 3.64 | 3.59 | 3.55 | 3.51 | 3.46 | 3.42 | 3.37 |
| 70.5 | 4.00 | 4.19 | 4.39 | 4.35 | 4.30 | 4.26 | 4.21 | 4.17 | 4.13 | 4.08 | 4.04 | 3.99 | 3.95 | 3.91 | 3.86 | 3.82 | 3.77 | 3.73 | 3.69 | 3.64 | 3.60 | 3.55 | 3.51 | 3.47 | 3.42 |
| 71.0 | 4.05 | 4.23 | 4.44 | 4.39 | 4.35 | 4.30 | 4.26 | 4.22 | 4.17 | 4.13 | 4.08 | 4.04 | 4.00 | 3.95 | 3.91 | 3.86 | 3.82 | 3.78 | 3.73 | 3.69 | 3.64 | 3.60 | 3.56 | 3.51 | 3.47 |
| 71.5 | 4.09 | 4.27 | 4.48 | 4.44 | 4.40 | 4.35 | 4.31 | 4.26 | 4.22 | 4.18 | 4.13 | 4.09 | 4.04 | 4.00 | 3.96 | 3.91 | 3.87 | 3.82 | 3.78 | 3.74 | 3.69 | 3.65 | 3.60 | 3.56 | 3.52 |
| 72.0 | 4.13 | 4.31 | 4.53 | 4.49 | 4.44 | 4.40 | 4.35 | 4.31 | 4.27 | 4.22 | 4.18 | 4.13 | 4.09 | 4.05 | 4.00 | 3.96 | 3.91 | 3.87 | 3.83 | 3.78 | 3.74 | 3.69 | 3.65 | 3.61 | 3.56 |
| 72.5 | 4.17 | 4.36 | 4.58 | 4.53 | 4.49 | 4.45 | 4.40 | 4.36 | 4.31 | 4.27 | 4.23 | 4.18 | 4.14 | 4.09 | 4.05 | 4.01 | 3.96 | 3.92 | 3.87 | 3.83 | 3.79 | 3.74 | 3.70 | 3.65 | 3.61 |
| 73.0 | 4.21 | 4.40 | 4.62 | 4.58 | 4.54 | 4.49 | 4.45 | 4.40 | 4.36 | 4.32 | 4.27 | 4.23 | 4.18 | 4.14 | 4.10 | 4.05 | 4.01 | 3.96 | 3.92 | 3.88 | 3.83 | 3.79 | 3.74 | 3.70 | 3.66 |
| 73.5 | 4.26 | 4.44 | 4.67 | 4.63 | 4.58 | 4.54 | 4.50 | 4.45 | 4.41 | 4.36 | 4.32 | 4.28 | 4.23 | 4.19 | 4.14 | 4.10 | 4.06 | 4.01 | 3.97 | 3.92 | 3.88 | 3.84 | 3.79 | 3.75 | 3.70 |
| 74.0 | 4.30 | 4.48 | 4.72 | 4.67 | 4.63 | 4.59 | 4.54 | 4.50 | 4.45 | 4.41 | 4.37 | 4.32 | 4.28 | 4.23 | 4.19 | 4.15 | 4.10 | 4.06 | 4.01 | 3.97 | 3.93 | 3.88 | 3.84 | 3.79 | 3.75 |
| 74.5 | 4.34 | 4.52 | 4.77 | 4.72 | 4.68 | 4.63 | 4.59 | 4.55 | 4.50 | 4.46 | 4.41 | 4.37 | 4.33 | 4.28 | 4.24 | 4.19 | 4.15 | 4.11 | 4.06 | 4.02 | 3.97 | 3.93 | 3.89 | 3.84 | 3.80 |
| 75.0 | 4.38 | 4.57 | 4.81 | 4.77 | 4.72 | 4.68 | 4.64 | 4.59 | 4.55 | 4.50 | 4.46 | 4.42 | 4.37 | 4.33 | 4.28 | 4.24 | 4.20 | 4.15 | 4.11 | 4.06 | 4.02 | 3.98 | 3.93 | 3.89 | 3.84 |
| 75.5 | 4.42 | 4.61 | 4.86 | 4.82 | 4.77 | 4.73 | 4.68 | 4.64 | 4.60 | 4.55 | 4.51 | 4.46 | 4.42 | 4.38 | 4.33 | 4.29 | 4.24 | 4.20 | 4.16 | 4.11 | 4.07 | 4.02 | 3.98 | 3.94 | 3.89 |
| 76.0 | 4.47 | 4.65 | 4.91 | 4.86 | 4.82 | 4.77 | 4.73 | 4.69 | 4.64 | 4.60 | 4.55 | 4.51 | 4.47 | 4.42 | 4.38 | 4.33 | 4.29 | 4.25 | 4.20 | 4.16 | 4.11 | 4.07 | 4.03 | 3.98 | 3.94 |
| 76.5 | 4.51 | 4.69 | 4.95 | 4.91 | 4.87 | 4.82 | 4.78 | 4.73 | 4.69 | 4.65 | 4.60 | 4.56 | 4.51 | 4.47 | 4.43 | 4.38 | 4.34 | 4.29 | 4.25 | 4.21 | 4.16 | 4.12 | 4.07 | 4.03 | 3.99 |
| 77.0 | 4.55 | 4.73 | 5.00 | 4.96 | 4.91 | 4.87 | 4.82 | 4.78 | 4.74 | 4.69 | 4.65 | 4.60 | 4.56 | 4.52 | 4.47 | 4.43 | 4.38 | 4.34 | 4.30 | 4.25 | 4.21 | 4.16 | 4.12 | 4.08 | 4.03 |

TABLE 4. PREDICTED FEV1 FOR FEMALES (KNUDSON, ET AL: AM REV RESPIR DIS, 1976, 113, 587.)

| AGE / HT | 17 | 19 | 21 | 23 | 25 | 27 | 29 | 31 | 33 | 35 | 37 | 39 | 41 | 43 | 45 | 47 | 49 | 51 | 53 | 55 | 57 | 59 | 61 | 63 | 65 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 52.0 | 2.31 | 2.48 | 2.33 | 2.29 | 2.25 | 2.21 | 2.16 | 2.12 | 2.08 | 2.04 | 2.00 | 1.95 | 1.91 | 1.87 | 1.83 | 1.79 | 1.74 | 1.70 | 1.66 | 1.62 | 1.58 | 1.53 | 1.49 | 1.45 | 1.41 |
| 52.5 | 2.34 | 2.51 | 2.37 | 2.32 | 2.28 | 2.24 | 2.20 | 2.16 | 2.11 | 2.07 | 2.03 | 1.99 | 1.95 | 1.90 | 1.86 | 1.82 | 1.78 | 1.74 | 1.69 | 1.65 | 1.61 | 1.57 | 1.53 | 1.48 | 1.44 |
| 53.0 | 2.38 | 2.55 | 2.40 | 2.36 | 2.32 | 2.27 | 2.23 | 2.19 | 2.15 | 2.11 | 2.06 | 2.02 | 1.98 | 1.94 | 1.90 | 1.85 | 1.81 | 1.77 | 1.73 | 1.69 | 1.64 | 1.60 | 1.56 | 1.52 | 1.48 |
| 53.5 | 2.41 | 2.58 | 2.43 | 2.39 | 2.35 | 2.31 | 2.27 | 2.22 | 2.18 | 2.14 | 2.10 | 2.06 | 2.01 | 1.97 | 1.93 | 1.89 | 1.85 | 1.80 | 1.76 | 1.72 | 1.68 | 1.64 | 1.59 | 1.55 | 1.51 |
| 54.0 | 2.45 | 2.62 | 2.47 | 2.43 | 2.38 | 2.34 | 2.30 | 2.26 | 2.22 | 2.17 | 2.13 | 2.09 | 2.05 | 2.01 | 1.96 | 1.92 | 1.88 | 1.84 | 1.80 | 1.75 | 1.71 | 1.67 | 1.63 | 1.59 | 1.54 |
| 54.5 | 2.48 | 2.65 | 2.50 | 2.46 | 2.42 | 2.38 | 2.33 | 2.29 | 2.25 | 2.21 | 2.17 | 2.12 | 2.08 | 2.04 | 2.00 | 1.96 | 1.91 | 1.87 | 1.83 | 1.79 | 1.75 | 1.70 | 1.66 | 1.62 | 1.58 |
| 55.0 | 2.51 | 2.68 | 2.54 | 2.49 | 2.45 | 2.41 | 2.37 | 2.33 | 2.28 | 2.24 | 2.20 | 2.16 | 2.12 | 2.07 | 2.03 | 1.99 | 1.95 | 1.91 | 1.86 | 1.82 | 1.78 | 1.74 | 1.70 | 1.65 | 1.61 |
| 55.5 | 2.55 | 2.72 | 2.57 | 2.53 | 2.49 | 2.45 | 2.40 | 2.36 | 2.32 | 2.28 | 2.24 | 2.19 | 2.15 | 2.11 | 2.07 | 2.03 | 1.98 | 1.94 | 1.90 | 1.86 | 1.82 | 1.77 | 1.73 | 1.69 | 1.65 |
| 56.0 | 2.58 | 2.75 | 2.61 | 2.56 | 2.52 | 2.48 | 2.44 | 2.40 | 2.35 | 2.31 | 2.27 | 2.23 | 2.19 | 2.14 | 2.10 | 2.06 | 2.02 | 1.98 | 1.93 | 1.89 | 1.85 | 1.81 | 1.77 | 1.72 | 1.68 |
| 56.5 | 2.62 | 2.79 | 2.64 | 2.60 | 2.56 | 2.51 | 2.47 | 2.43 | 2.39 | 2.35 | 2.30 | 2.26 | 2.22 | 2.18 | 2.14 | 2.09 | 2.05 | 2.01 | 1.97 | 1.93 | 1.88 | 1.84 | 1.80 | 1.76 | 1.72 |
| 57.0 | 2.65 | 2.82 | 2.67 | 2.63 | 2.59 | 2.55 | 2.51 | 2.46 | 2.42 | 2.38 | 2.34 | 2.30 | 2.25 | 2.21 | 2.17 | 2.13 | 2.09 | 2.04 | 2.00 | 1.96 | 1.92 | 1.88 | 1.83 | 1.79 | 1.75 |
| 57.5 | 2.69 | 2.86 | 2.71 | 2.67 | 2.62 | 2.58 | 2.54 | 2.50 | 2.46 | 2.41 | 2.37 | 2.33 | 2.29 | 2.25 | 2.20 | 2.16 | 2.12 | 2.08 | 2.04 | 1.99 | 1.95 | 1.91 | 1.87 | 1.83 | 1.78 |
| 58.0 | 2.72 | 2.89 | 2.74 | 2.70 | 2.66 | 2.62 | 2.57 | 2.53 | 2.49 | 2.45 | 2.41 | 2.36 | 2.32 | 2.28 | 2.24 | 2.20 | 2.15 | 2.11 | 2.07 | 2.03 | 1.99 | 1.94 | 1.90 | 1.86 | 1.82 |
| 58.5 | 2.75 | 2.92 | 2.78 | 2.73 | 2.69 | 2.65 | 2.61 | 2.57 | 2.52 | 2.48 | 2.44 | 2.40 | 2.36 | 2.31 | 2.27 | 2.23 | 2.19 | 2.15 | 2.10 | 2.06 | 2.02 | 1.98 | 1.94 | 1.89 | 1.85 |
| 59.0 | 2.79 | 2.96 | 2.81 | 2.77 | 2.73 | 2.69 | 2.64 | 2.60 | 2.56 | 2.52 | 2.48 | 2.43 | 2.39 | 2.35 | 2.31 | 2.27 | 2.22 | 2.18 | 2.14 | 2.10 | 2.06 | 2.01 | 1.97 | 1.93 | 1.89 |
| 59.5 | 2.82 | 2.99 | 2.85 | 2.80 | 2.76 | 2.72 | 2.68 | 2.64 | 2.59 | 2.55 | 2.51 | 2.47 | 2.43 | 2.38 | 2.34 | 2.30 | 2.26 | 2.22 | 2.17 | 2.13 | 2.09 | 2.05 | 2.01 | 1.96 | 1.92 |
| 60.0 | 2.86 | 3.03 | 2.88 | 2.84 | 2.80 | 2.75 | 2.71 | 2.67 | 2.63 | 2.59 | 2.54 | 2.50 | 2.46 | 2.42 | 2.38 | 2.33 | 2.29 | 2.25 | 2.21 | 2.17 | 2.12 | 2.08 | 2.04 | 2.00 | 1.96 |
| 60.5 | 2.89 | 3.06 | 2.91 | 2.87 | 2.83 | 2.79 | 2.75 | 2.70 | 2.66 | 2.62 | 2.58 | 2.54 | 2.49 | 2.45 | 2.41 | 2.37 | 2.33 | 2.28 | 2.24 | 2.20 | 2.16 | 2.12 | 2.07 | 2.03 | 1.99 |
| 61.0 | 2.93 | 3.10 | 2.95 | 2.91 | 2.86 | 2.82 | 2.78 | 2.74 | 2.70 | 2.65 | 2.61 | 2.57 | 2.53 | 2.49 | 2.44 | 2.40 | 2.36 | 2.32 | 2.28 | 2.23 | 2.19 | 2.15 | 2.11 | 2.07 | 2.02 |
| 61.5 | 2.96 | 3.13 | 2.98 | 2.94 | 2.90 | 2.86 | 2.81 | 2.77 | 2.73 | 2.69 | 2.65 | 2.60 | 2.56 | 2.52 | 2.48 | 2.44 | 2.39 | 2.35 | 2.31 | 2.27 | 2.23 | 2.18 | 2.14 | 2.10 | 2.06 |
| 62.0 | 2.99 | 3.16 | 3.02 | 2.97 | 2.93 | 2.89 | 2.85 | 2.81 | 2.76 | 2.72 | 2.68 | 2.64 | 2.60 | 2.55 | 2.51 | 2.47 | 2.43 | 2.39 | 2.34 | 2.30 | 2.26 | 2.22 | 2.18 | 2.13 | 2.09 |
| 62.5 | 3.03 | 3.20 | 3.05 | 3.01 | 2.97 | 2.93 | 2.88 | 2.84 | 2.80 | 2.76 | 2.72 | 2.67 | 2.63 | 2.59 | 2.55 | 2.51 | 2.46 | 2.42 | 2.38 | 2.34 | 2.30 | 2.25 | 2.21 | 2.17 | 2.13 |
| 63.0 | 3.06 | 3.23 | 3.09 | 3.04 | 3.00 | 2.96 | 2.92 | 2.88 | 2.83 | 2.79 | 2.75 | 2.71 | 2.67 | 2.62 | 2.58 | 2.54 | 2.50 | 2.46 | 2.41 | 2.37 | 2.33 | 2.29 | 2.25 | 2.20 | 2.16 |
| 63.5 | 3.10 | 3.27 | 3.12 | 3.08 | 3.04 | 2.99 | 2.95 | 2.91 | 2.87 | 2.83 | 2.78 | 2.74 | 2.70 | 2.66 | 2.62 | 2.57 | 2.53 | 2.49 | 2.45 | 2.41 | 2.36 | 2.32 | 2.28 | 2.24 | 2.20 |
| 64.0 | 3.13 | 3.30 | 3.15 | 3.11 | 3.07 | 3.03 | 2.99 | 2.94 | 2.90 | 2.86 | 2.82 | 2.78 | 2.73 | 2.69 | 2.65 | 2.61 | 2.57 | 2.52 | 2.48 | 2.44 | 2.40 | 2.36 | 2.31 | 2.27 | 2.23 |
| 64.5 | 3.17 | 3.34 | 3.19 | 3.15 | 3.10 | 3.06 | 3.02 | 2.98 | 2.94 | 2.89 | 2.85 | 2.81 | 2.77 | 2.73 | 2.68 | 2.64 | 2.60 | 2.56 | 2.52 | 2.47 | 2.43 | 2.39 | 2.35 | 2.31 | 2.26 |
| 65.0 | 3.20 | 3.37 | 3.22 | 3.18 | 3.14 | 3.10 | 3.05 | 3.01 | 2.97 | 2.93 | 2.89 | 2.84 | 2.80 | 2.76 | 2.72 | 2.68 | 2.63 | 2.59 | 2.55 | 2.51 | 2.47 | 2.42 | 2.38 | 2.34 | 2.30 |
| 65.5 | 3.23 | 3.40 | 3.26 | 3.21 | 3.17 | 3.13 | 3.09 | 3.05 | 3.00 | 2.96 | 2.92 | 2.88 | 2.84 | 2.79 | 2.75 | 2.71 | 2.67 | 2.63 | 2.58 | 2.54 | 2.50 | 2.46 | 2.42 | 2.37 | 2.33 |
| 66.0 | 3.27 | 3.44 | 3.29 | 3.25 | 3.21 | 3.17 | 3.12 | 3.08 | 3.04 | 3.00 | 2.96 | 2.91 | 2.87 | 2.83 | 2.79 | 2.75 | 2.70 | 2.66 | 2.62 | 2.58 | 2.54 | 2.49 | 2.45 | 2.41 | 2.37 |
| 66.5 | 3.30 | 3.47 | 3.33 | 3.28 | 3.24 | 3.20 | 3.16 | 3.12 | 3.07 | 3.03 | 2.99 | 2.95 | 2.91 | 2.86 | 2.82 | 2.78 | 2.74 | 2.70 | 2.65 | 2.61 | 2.57 | 2.53 | 2.49 | 2.44 | 2.40 |
| 67.0 | 3.34 | 3.51 | 3.36 | 3.32 | 3.28 | 3.23 | 3.19 | 3.15 | 3.11 | 3.07 | 3.02 | 2.98 | 2.94 | 2.90 | 2.86 | 2.81 | 2.77 | 2.73 | 2.69 | 2.65 | 2.60 | 2.56 | 2.52 | 2.48 | 2.44 |
| 67.5 | 3.37 | 3.54 | 3.39 | 3.35 | 3.31 | 3.27 | 3.23 | 3.18 | 3.14 | 3.10 | 3.06 | 3.02 | 2.97 | 2.93 | 2.89 | 2.85 | 2.81 | 2.76 | 2.72 | 2.68 | 2.64 | 2.60 | 2.55 | 2.51 | 2.47 |
| 68.0 | 3.41 | 3.58 | 3.43 | 3.39 | 3.34 | 3.30 | 3.26 | 3.22 | 3.18 | 3.13 | 3.09 | 3.05 | 3.01 | 2.97 | 2.92 | 2.88 | 2.84 | 2.80 | 2.76 | 2.71 | 2.67 | 2.63 | 2.59 | 2.55 | 2.50 |
| 68.5 | 3.44 | 3.61 | 3.46 | 3.42 | 3.38 | 3.34 | 3.29 | 3.25 | 3.21 | 3.17 | 3.13 | 3.08 | 3.04 | 3.00 | 2.96 | 2.92 | 2.87 | 2.83 | 2.79 | 2.75 | 2.71 | 2.66 | 2.62 | 2.58 | 2.54 |
| 69.0 | 3.47 | 3.64 | 3.50 | 3.46 | 3.41 | 3.37 | 3.33 | 3.29 | 3.25 | 3.20 | 3.16 | 3.12 | 3.08 | 3.04 | 2.99 | 2.95 | 2.91 | 2.87 | 2.83 | 2.78 | 2.74 | 2.70 | 2.66 | 2.62 | 2.57 |
| 69.5 | 3.51 | 3.68 | 3.53 | 3.49 | 3.45 | 3.41 | 3.36 | 3.32 | 3.28 | 3.24 | 3.20 | 3.15 | 3.11 | 3.07 | 3.03 | 2.99 | 2.94 | 2.90 | 2.86 | 2.82 | 2.78 | 2.73 | 2.69 | 2.65 | 2.61 |
| 70.0 | 3.54 | 3.71 | 3.57 | 3.52 | 3.48 | 3.44 | 3.40 | 3.36 | 3.31 | 3.27 | 3.23 | 3.19 | 3.15 | 3.10 | 3.06 | 3.02 | 2.98 | 2.94 | 2.89 | 2.85 | 2.81 | 2.77 | 2.73 | 2.68 | 2.64 |
| 70.5 | 3.58 | 3.75 | 3.60 | 3.56 | 3.52 | 3.47 | 3.43 | 3.39 | 3.35 | 3.31 | 3.26 | 3.22 | 3.18 | 3.14 | 3.10 | 3.05 | 3.01 | 2.97 | 2.93 | 2.89 | 2.84 | 2.80 | 2.76 | 2.72 | 2.68 |
| 71.0 | 3.61 | 3.78 | 3.63 | 3.59 | 3.55 | 3.51 | 3.47 | 3.42 | 3.38 | 3.34 | 3.30 | 3.26 | 3.21 | 3.17 | 3.13 | 3.09 | 3.05 | 3.00 | 2.96 | 2.92 | 2.88 | 2.84 | 2.79 | 2.75 | 2.71 |
| 71.5 | 3.65 | 3.82 | 3.67 | 3.63 | 3.58 | 3.54 | 3.50 | 3.46 | 3.42 | 3.37 | 3.33 | 3.29 | 3.25 | 3.21 | 3.16 | 3.12 | 3.08 | 3.04 | 3.00 | 2.95 | 2.91 | 2.87 | 2.83 | 2.79 | 2.74 |
| 72.0 | 3.68 | 3.85 | 3.70 | 3.66 | 3.62 | 3.58 | 3.53 | 3.49 | 3.45 | 3.41 | 3.37 | 3.32 | 3.28 | 3.24 | 3.20 | 3.16 | 3.11 | 3.07 | 3.03 | 2.99 | 2.95 | 2.90 | 2.86 | 2.82 | 2.78 |
| 72.5 | 3.71 | 3.88 | 3.74 | 3.70 | 3.65 | 3.61 | 3.57 | 3.53 | 3.49 | 3.44 | 3.40 | 3.36 | 3.32 | 3.28 | 3.23 | 3.19 | 3.15 | 3.11 | 3.07 | 3.02 | 2.98 | 2.94 | 2.90 | 2.86 | 2.81 |
| 73.0 | 3.75 | 3.92 | 3.77 | 3.73 | 3.69 | 3.65 | 3.60 | 3.56 | 3.52 | 3.48 | 3.44 | 3.39 | 3.35 | 3.31 | 3.27 | 3.23 | 3.18 | 3.14 | 3.10 | 3.06 | 3.02 | 2.97 | 2.93 | 2.89 | 2.85 |
| 73.5 | 3.78 | 3.95 | 3.81 | 3.76 | 3.72 | 3.68 | 3.64 | 3.60 | 3.55 | 3.51 | 3.47 | 3.43 | 3.39 | 3.34 | 3.30 | 3.26 | 3.22 | 3.18 | 3.13 | 3.09 | 3.05 | 3.01 | 2.97 | 2.92 | 2.88 |
| 74.0 | 3.82 | 3.99 | 3.84 | 3.80 | 3.76 | 3.71 | 3.67 | 3.63 | 3.59 | 3.55 | 3.50 | 3.46 | 3.42 | 3.38 | 3.34 | 3.29 | 3.25 | 3.21 | 3.17 | 3.13 | 3.08 | 3.04 | 3.00 | 2.96 | 2.92 |
| 74.5 | 3.85 | 4.02 | 3.87 | 3.83 | 3.79 | 3.75 | 3.71 | 3.66 | 3.62 | 3.58 | 3.54 | 3.50 | 3.45 | 3.41 | 3.37 | 3.33 | 3.29 | 3.24 | 3.20 | 3.16 | 3.12 | 3.08 | 3.03 | 2.99 | 2.95 |
| 75.0 | 3.89 | 4.06 | 3.91 | 3.87 | 3.82 | 3.78 | 3.74 | 3.70 | 3.66 | 3.61 | 3.57 | 3.53 | 3.49 | 3.45 | 3.40 | 3.36 | 3.32 | 3.28 | 3.24 | 3.19 | 3.15 | 3.11 | 3.07 | 3.03 | 2.98 |
| 75.5 | 3.92 | 4.09 | 3.94 | 3.90 | 3.86 | 3.82 | 3.77 | 3.73 | 3.69 | 3.65 | 3.61 | 3.56 | 3.52 | 3.48 | 3.44 | 3.40 | 3.35 | 3.31 | 3.27 | 3.23 | 3.19 | 3.14 | 3.10 | 3.06 | 3.02 |
| 76.0 | 3.95 | 4.12 | 3.98 | 3.94 | 3.89 | 3.85 | 3.81 | 3.77 | 3.73 | 3.68 | 3.64 | 3.60 | 3.56 | 3.52 | 3.47 | 3.43 | 3.39 | 3.35 | 3.31 | 3.26 | 3.22 | 3.18 | 3.14 | 3.10 | 3.05 |
| 76.5 | 3.99 | 4.16 | 4.01 | 3.97 | 3.93 | 3.89 | 3.84 | 3.80 | 3.76 | 3.72 | 3.68 | 3.63 | 3.59 | 3.55 | 3.51 | 3.47 | 3.42 | 3.38 | 3.34 | 3.30 | 3.26 | 3.21 | 3.17 | 3.13 | 3.09 |
| 77.0 | 4.02 | 4.19 | 4.05 | 4.00 | 3.96 | 3.92 | 3.88 | 3.84 | 3.79 | 3.75 | 3.71 | 3.67 | 3.63 | 3.58 | 3.54 | 3.50 | 3.46 | 3.42 | 3.37 | 3.33 | 3.29 | 3.25 | 3.21 | 3.16 | 3.12 |

[4510-26-M]

APPENDIX D—PULMONARY FUNCTION STANDARDS FOR COTTON DUST STANDARD

The spirometric measurements of pulmonary function shall conform to the following minimum standards, and these standards are not intended to preclude additional testing or alternate methods which can be determined to be superior.

I. APPARATUS

a. The instrument shall be accurate to within ±50 milliliters or within ±3 percent of reading, whichever is greater.

b. The instrument should be capable of measuring vital capacity from 0 to 7 liters BTPS.

c. The instrument shall have a low inertia and offer low resistance to airflow such that the resistance to airflow at 12 liters per second must be less than 1.5 cm $H_2O$/(liter/sec).

d. The zero time point for the purpose of timing the $FEV_1$ shall be determined by extrapolating the steepest portion of the volume time curve back to the maximal inspiration volume (1, 2, 3, 4) or by an equivalent method.

e. Instruments incorporating measurements of airflow to determine volume shall conform to the same volume accuracy stated in (a) of this section when presented with flow rates from at least 0 to 12 liters per second.

f. The instrument or user of the instrument must have a means of correcting volumes to body temperature saturated with water vapor (BTPS) under conditions of varying ambient spirometer temperatures and barometric pressures.

g. The instrument used shall provide a tracing or display of either flow versus volume or volume versus time during the entire forced expiration. A tracing or display is necessary to determine whether the patient has performed the test properly. The tracing must be stored and available for recall and must be of sufficient size that hand measurements may be made within requirement of paragraph (a) of this section. If a paper record is made it must have a paper speed of at least 2 cm/sec and a volume sensitivity of at least 10.0 mm of chart per liter of volume.

h. The instrument shall be capable of accumulating volume for a minimum of 10 seconds and shall not stop accumulating volume before (1) the volume change for a 0.5 second interval is less than 25 milliliters, or (2) the flow is less than 50 milliliters per second for a 0.5 second interval.

i. The forced vital capacity (FVC) and forced expiratory volume in 1 second ($FEV_{1.0}$) measurements shall comply with the accuracy requirements stated in paragraph (a) of this section. That is, they should be accurately measured to within ±50 ml or within ±3 percent of reading, whichever is greater.

j. The instrument must be capable of being calibrated in the field with respect to the $FEV_1$ and FVC. This calibration of the $FEV_1$ and FVC may be either directly or indirectly through volume and time base measurements. The volume calibration source should provide a volume displacement of at least 2 liters and should be accurate to within ±30 milliliters.

II. TECHNIQUE FOR MEASUREMENT OF FORCED VITAL CAPACITY MANEUVER

a. Use of a nose clip is recommended but not required. The procedures shall be explained in simple terms to the patient who shall be instructed to loosen any tight clothing and stand in front of the apparatus. The subject may sit, but care should be taken on repeat testing that the same position be used and, if possible, the same spirometer. Particular attention shall be given to insure that the chin is slightly elevated with the neck slightly extended. The patient shall be instructed to make a full inspiration from a normal breathing pattern and then blow into the apparatus, without interruption, as hard, fast, and completely as possible. At least three forced expirations shall be carried out. During the maneuvers, the patient shall be observed for compliance with instruction. The expirations shall be checked visually for reproducibility from flow-volume or volume-time tracings or displays. The following efforts shall be judged unacceptable when the patient:

1. Has not reached full inspiration preceding the forced expiration,

2. Has not used maximal effort during the entire forced expiration,

3. Has not continued the expiration for at least 5 seconds or until an obvious plateau in the volume time curve has occurred,

4. Has coughed or closed his glottis,

5. Has an obstructed mouthpiece or a leak around the mouthpiece (obstruction due to tongue being placed in front of mouthpiece, false teeth falling in front of mouthpiece, etc.)

6. Has an unsatisfactory start of expiration, one characterized by excessive hesitation (or false starts), and therefore not allowing back extrapolation of time 0 (extrapolated volume on the volume time tracing must be less than 10 percent of the FVC.)

7. Has an excessive variability between the three acceptable curves. The variation between the two largest FVC's and $FEV_1$'s of the three satisfactory tracings should not exceed 10 percent or ± 100 milliliters, whichever is greater.

b. Periodic and routine recalibration of the instrument or method for recording FVC and $FEV_{1.0}$ should be performed using a syringe or other volume source of at least 2 liters.

III. INTERPRETATION OF SPIROGRAM

a. The first step in evaluating a spirogram should be to determine whether or not the patient has performed the test properly or as described in II above. From the three satisfactory tracings, the forced vital capacity (FVC) and forced expiratory volume in 1 second ($FEV_{1.0}$) shall be measured and recorded. The largest observed FVC and largest observed $FEV_1$ shall be used in the analysis regardless of the curve(s) on which they occur.

b. The following guidelines are recommended by NIOSH for the evaluation and management of workers exposed to cotton dust. It is important to note that employees who show reductions in $FEV_1$/FVC ratio below .75 or drops in Monday $FEV_1$ of 5 percent or greater on their initial screening exam, should be re-evaluated within a month of the first exam. Those who show consistent decrease in lung function, as shown on the following table, should be managed as recommended.

IV. QUALIFICATIONS OF PERSONNEL ADMINISTERING THE TEST

Technicians who perform pulmonary function testing should have the basic knowledge required to produce meaningful results. Training consisting of approximately 16 hours of formal instruction should cover the following areas. Persons who successfully complete the course will be certified by OSHA or their designee.

a. Basic physiology of the forced vital capacity maneuver and the determinants of airflow limitation with emphasis on the relation to reproducibility of results.

b. Instrumentation requirements including calibration procedures, sources of error and their correction.

c. Performance of the testing including subject coaching, recognition of improperly performed maneuvers and corrective actions.

d. Data quality with emphasis on reproducibility.

e. Actual use of the equipment under supervised conditions.

f. Measurement of tracings and calculations of results.

**§ 1910.1044 1,2-dibromo-3-chloropropane.**

(a) *Scope and application.* (1) This section applies to occupational exposure to 1,2-dibromo-3-chloropropane (DBCP).

(2) This section does not apply to:

(i) Exposure to DBCP which results solely from the application and use of DBCP as a pesticide; or

(ii) The storage, transportation, distribution or sale of DBCP in intact containers sealed in such a manner as to prevent exposure to DBCP vapors or liquid, except for the requirements of paragraphs (i), (n) and (o) of this section.

(b) *Definitions.* "Authorized person" means any person required by his duties to be present in regulated areas and authorized to do so by his employer, by this section, or by the Act. "Authorized person" also includes any person entering such areas as a designated representative of employees exercising an opportunity to observe employee exposure monitoring.

"DBCP" means 1,2-dibromo-3-chloropropane, Chemical Abstracts Service Registry Number 96-12-8, and includes all forms of DBCP.

"Director" means the Director, National Institute for Occupational Safety and Health, U.S. Department of Health, Education and Welfare, or designee.

"Emergency" means any occurrence such as, but not limited to equipment failure, rupture of containers, or failure of control equipment which may, or does, result in an unexpected release of DBCP.

"OSHA Area Office" means the Area Office of the Occupational Safety and Health Administration having jurisdiction over the geographic area where the affected workplace is located.

"Assistant Secretary" means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

(c) *Permissible exposure limit*—(1) *Inhalation.* The employer shall assure that no employee is exposed to an airborne concentration of DBCP in excess of 1 part DBCP per billion parts of air (ppb) as an 8-hour time-weighted average.

(2) *Dermal and eye exposure.* The employer shall assure that no employee is exposed to eye or skin contact with DBCP.

(d) *Notification of use.* Within ten (10) days following the introduction of DBCP into the workplace, every employer who has a workplace where DBCP is present, shall report the following information to the nearest OSHA Area Office for each such workplace;

(1) The address and location of the workplace:

(2) A brief description of each process or operation which may result in employee exposure to DBCP;

(3) The number of employees engaged in each process or operation who may be exposed to DBCP and an estimate of the frequency and degree of exposure that occurs; and

(4) A brief description of the employer's safety and health program as it relates to limitation of employee exposure to DBCP.

(e) *Regulated areas.* (1) The employer shall establish, within each place of employment, regulated areas wherever DBCP concentrations are in excess of the permissible exposure limit.

(2) The employer shall limit access to regulated areas to authorized persons.

(f) *Exposure monitoring*—(1) *General.* (i) Determinations of airborne exposure levels shall be made from air samples that are representative of each employee's exposure to DBCP over an 8-hour period.

(ii) For the purposes of this paragraph, employee exposure is that exposure which would occur if the employee were not using a respirator.

(2) *Initial.* Each employer who has a place of employment in which DBCP is present, shall monitor each workplace and work operation to accurately determine the airborne concentrations of DBCP to which employees may be exposed.

(3) *Frequency.* (i) If the monitoring required by this section reveals employee exposures to be below the permissible exposure limit, the employer shall repeat these measurements at least quarterly.

(ii) If the monitoring required by this section reveals employee exposures to be in excess of the permissible exposure limit, the employer shall repeat these measurements for each such employee at least monthly. The employer shall continue monthly monitoring until at least two consecutive measurements, taken at least seven (7) days apart, are below the permissible exposure limit. Thereafter the employer shall monitor at least quarterly.

(4) *Additional.* Whenever there has been a production, process, control, or personnel change which may result in any new or additional exposure to DBCP, or whenever the employer has any reason to suspect new or additional exposures to DBCP, the employer shall monitor the employees potentially affected by such change for the purpose of redetermining their exposure.

(5) *Employee notification.* (i) Within five (5) working days after the receipt of monitoring results, the employer shall notify each employee in writing of the measurements which represent the employee's exposure.

(ii) Whenever the results indicate that employee exposure exceeds the permissible exposure limit, the employer shall include in the written notice a statement that the permissible exposure limit was exceeded and a description of the corrective action being taken to reduce exposure to or below the permissible exposure limit.

(6) *Accuracy of measurement.* The employer shall use a method of measurement which has an accuracy, to a confidence level of 95 percent, of not less than plus or minus 25 percent for concentrations of DBCP at or above the permissible exposure limit.

(g) *Methods of compliance*—(1) *Priority of compliance methods.* The employer shall institute engineering and work practice controls to reduce and maintain employee exposures to DBCP at or below the permissible exposure limit, except to the extent that the employer establishes that such controls are not feasible. Where feasible engineering and work practice controls are not sufficient to reduce employee exposures to within the permissible exposure limit, the employer shall nonetheless use them to reduce exposures to the lowest level achievable by these controls, and shall supplement them by use of respiratory protection.

(2) *Compliance program.* (i) The employer shall establish and implement a written program to reduce employee exposures to DBCP to or below the permissible exposure limit solely by means of engineering and work practice controls as required by paragraph (g)(1) of this section.

(ii) The written program shall include a detailed schedule for development and implementation of the engineering and work practice controls. These plans shall be revised at least every six months to reflect the current status of the program.

(iii) Written plans for these compliance programs shall be submitted upon request to the Assistant Secretary and the Director, and shall be available at the worksite for examination and copying by the Assistant Secretary, the Director, and any affected employee or designated representative of employees.

(iv) The employer shall institute and maintain at least the controls described in his most recent written compliance program.

(h) *Respirators*—(1) *General.* Where respiratory protection is required under this section, the employer shall select, provide and assure the proper use of respirators. Respirators shall be used in the following circumstances:

(i) During the period necessary to install or implement feasible engineering and work practice controls; or

(ii) During maintenance and repair activities in which engineering and work practice controls are not feasible; or

(iii) In work situations where feasible engineering and work practice controls are not yet sufficient to reduce exposure to or below the permissible exposure limit; or

(iv) In emergencies.

(2) *Respirator selection.* (i) Where respirators are required under this section, the employer shall select and provide, at no cost to the employee, the appropriate respirator from Table 1 below and shall assure that the employee uses the respirator provided.

(ii) The employer shall select respirators from among those approved by the National Institute for Occupational Safety and Health (NIOSH) under the provisions of 30 CFR Part 11.

TABLE 1.—*Respiratory protection for DBCP*

| Airborne concentration of DBCP or condition of use | Respirator type |
|---|---|
| (a) Less than or equal to 10 ppb. | (1) Any supplied-air respirator or (2) any self-contained breathing apparatus. |
| (b) Less than or equal to 50 ppb. | (1) Any supplied-air respirator with full facepiece, helmet, or hood; or (2) any self-contained breathing apparatus with full facepiece. |
| (c) Less than or equal to 1,000 ppb. | (1) A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous flow mode. |
| (d) Less than or equal to 2,000 ppb. | (1) A Type C supplied-air respirator with full facepiece operated in pressure-demand or other positive pressure mode, or with full facepiece, helmet, or hood operated in continuous flow mode. |

TABLE 1.—*Respiratory protection for DBCP*—Continued

| Airborne concentration of DBCP or condition of use | Respirator type |
|---|---|
| (e) Greater than 2,000 ppb or entry and escape from unknown concentrations. | (1) A combination respirator which includes a Type C supplied-air respirator with full facepiece operated in pressure-demand or other positive pressure or continuous flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or positive pressure mode; or (2) a self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive pressure mode. |
| (f) Firefighting | (1) A self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive pressure mode. |

(3) *Respirator program.* (i) The employer shall institute a respiratory protection program in accordance with 29 CFR 1910.134 (b), (d), (e), and (f).

(ii) Employees who wear respirators shall be allowed to wash their faces and respirator facepieces as needed to prevent potential skin irritation associated with respirator use.

(i) *Emergency situations*—(1) *Written plan.* (i) A written plan for emergency situations shall be developed for each workplace in which DBCP is present.

(ii) Appropriate portions of the plan shall be implemented in the event of an emergency.

(2) Employees engaged in correcting emergency conditions shall be equipped as required in paragraphs (h) and (j) of this section until the emergency is abated.

(3) *Evacuation.* Employees not engaged in correcting the emergency shall be removed and restricted from the area and normal operations in the affected area shall not be resumed until the emergency is abated.

(4) *Alerting employees.* Where there is a possibility of employee exposure to DBCP due to the occurrence of an emergency, a general alarm shall be installed and maintained to promptly alert employees of such occurrences.

(5) *Medical surveillance.* For any employee exposed to DBCP in an emergency situation, the employer shall provide medical surveillance in accordance with paragraph (m)(6) of this section.

(6) *Exposure monitoring.* (i) Following an emergency, the employer shall conduct monitoring which complies with paragraph (f) of this section.

(ii) In workplaces not normally subject to periodic monitoring, the employer may terminate monitoring when two consecutive measurements indicate exposures below the permissible exposure limit.

(j) *Protective clothing and equipments*—(1) *Provision and use.* Where there is any possibility of eye or dermal contact with liquid or solid DBCP, the employer shall provide, at no cost to the employee, and assure that the employee wears impermeable protective clothing and equipment to protect the area of the body which may come in contact with DBCP. Eye and face protection shall meet the requirements of § 1910.133 of this part.

(2) *Removal and storage.* (i) The employer shall assure that employees remove DBCP contaminated work clothing only in change rooms provided in accordance with paragraph (l)(1) of this section.

(ii) The employer shall assure that employees promptly remove any protective clothing and equipment which becomes contaminated with DBCP-containing liquids and solids. This clothing shall not be reworn until the DBCP has been removed from the clothing or equipment.

(iii) The employer shall assure that no employee takes DBCP contaminated protective devices and work clothing out of the change room, except those employees authorized to do so for the purpose of laundering, maintenance, of disposal.

(iv) DBCP-contaminated protective devices and work clothing shall be placed and stored in closed containers which prevent dispersion of the DBCP outside the container.

(v) Containers of DBCP contaminated protective devices or work clothing which are to be taken out of change rooms or the workplace for cleaning, maintenance or disposal, shall bear labels in accordance with paragraph (o)(3) of this section.

(3) *Cleaning and replacement.* (i) The employer shall clean, launder, repair, or replace protective clothing and equipment required by this paragraph to maintain their effectiveness. The employer shall provide clean protective clothing and equipment at least daily to each affected employee.

(ii) The employer shall inform any person who launders or cleans DBCP-contaminated protective clothing or equipment of the potentially harmful effects of exposure to DBCP.

(iii) The employer shall prohibit the removal of DBCP from protective clothing and equipment by blowing or shaking.

(k) *Housekeeping*—(1) *Surfaces.* (i) All workplace surfaces shall be maintained free of visible accumulations of DBCP.

(ii) Dry sweeping and the use of compressed air for the cleaning of floors and other surfaces is prohibited where DBCP dusts or liquids are present.

(iii) Where vacuuming methods are selected to clean floors and other surfaces, either portable units or a permanent system may be used.

(A) If a portable unit is selected, the exhaust shall be attached to the general workplace exhaust ventilation system or collected within the vacuum unit, equipped with high efficiency filters or other appropriate means of contaminant removal, so that DBCP is not reintroduced into the workplace air; and

(B) Portable vacuum units used to collect DBCP may not be used for other cleaning purposes and shall be labeled as prescribed by paragraph (o)(3) of this section.

(iv) Cleaning of floors and other surfaces contaminated with DBCP-containing dusts shall not be performed by washing down with a hose, unless a fine spray has first been laid down.

(2) *Liquids.* Where DBCP is present in a liquid form, or as a resultant vapor, all containers or vessels containing DBCP shall be enclosed to the maximum extent feasible and tightly covered when not in use.

(3) *Waste disposal.* DBCP waste scrap, debris, containers or equipment, shall be disposed of in sealed bags or other closed containers which prevent dispersion of DBCP outside the container.

(l) *Hygiene facilities and practices*—(1) *Change rooms.* The employer shall provide clean change rooms equipped with storage facilities for street clothes and separate storage facilities for protective clothing and equipment whenever employees are required to wear protective clothing and equipment in accordance with paragraphs (h) and (j) of this section.

(2) *Showers.* (i) The employer shall assure that employees working in the regulated area shower at the end of the work shift.

(ii) The employer shall assure that employees whose skin becomes contaminated with DBCP-containing liquids or solids immediately wash or shower to remove any DBCP from the skin.

(iii) The employer shall provide shower facilities in accordance with 29 CFR 1910.141(d)(3).

(3) *Lunchrooms.* The employer shall provide lunchroom facilities which have a temperature controlled, positive pressure, filtered air supply, and which are readily accessible to employees working in regulated areas.

(4) *Lavatories.* (i) The employer shall assure that employees working in the regulated area remove protective

clothing and wash their hands and face prior to eating.

(ii) The employer shall provide a sufficient number of lavatory facilities which comply with 29 CFR 1910.141(d) (1) and (2).

(5) *Prohibition of activities in regulated areas.* The employer shall assure that, in regulated areas, food or beverages are not present or consumed, smoking products and implements are not present or used, and cosmetics are not present or applied.

(m) *Medical surveillance*—(1) *General.* (i) The employer shall make available a medical surveillance program for employees who work in regulated areas and employees who are subjected to DBCP exposures in an emergency situation.

(ii) All medical examinations and procedures shall be performed by or under the supervision of a licensed physician, and shall be provided without cost to the employee.

(2) *Frequency and content.* At the time of initial assignment, and annually thereafter, the employer shall provide a medical examination for employees who work in regulated areas, which includes at least the following:

(i) A medical and occupational history including reproductive history.

(ii) A physical examination, including examination of the genito-urinary tract, testicle size and body habitus, including a determination of sperm count.

(iii) A serum specimen shall be obtained and the following determinations made by radioimmunoassay techniques utilizing National Institutes of Health (NIH) specific antigen or one of equivalent sensitivity:

(A) Serum follicle stimulating hormone (FSH);

(B) Serum luteinizing hormone (LH); and

(C) Serum total estrogen (females).

(iv) Any other tests deemed appropriate by the examining physician.

(3) *Additional examinations.* If the employee for any reason develops signs or symptoms commonly associated with exposure to DBCP, the employer shall provide the employee with a medical examination which shall include those elements considered appropriate by the examining physician.

(4) *Information provided to the physician.* The employer shall provide the following information to the examining physician:

(i) A copy of this regulation and its appendices;

(ii) A description of the affected employee's duties as they relate to the employee's exposure;

(iii) The level of DBCP to which the employee is exposed; and

(iv) A description of any personal protective equipment used or to be used.

(5) *Physician's written opinion.* (i) For each examination under this section, the employer shall obtain and provide the employee with a written opinion from the examining physician which shall include:

(A) The results of the medical tests performed;

(B) The physician's opinion as to whether the employee has any detected medical condition which would place the employee at an increased risk of material impairment of health from exposure to DBCP; and

(C) Any recommended limitations upon the employee's exposure to DBCP or upon the use of protective clothing and equipment such as respirators.

(ii) The employer shall instruct the physician not to reveal in the written opinion specific findings or diagnoses unrelated to occupational exposure.

(6) *Emergency situations.* If the employee is exposed to DBCP in an emergency situation, the employer shall provide the employee with a sperm count test as soon as practicable, or, if the employee has been vasectionized or is unable to produce a semen specimen, the hormone tests contained in paragraph (m)(2)(iii) of this section. The employer shall provide these same tests three months later.

(n) *Employee information and training*—(1) *Training program.* (i) The employer shall institute a training program for all employees who may be exposed to DBCP and shall assure their participation in such training program.

(ii) The employer shall assure that each employee is informed of the following:

(*a*) The information contained in Appendix A;

(*b*) The quantity, location, manner of use, release or storage of DBCP and the specific nature of operations which could result in exposure to DBCP as well as any necessary protective steps;

(*c*) The purpose, proper use, and limitations of respirators;

(*d*) The purpose and description of the medical surveillance program required by paragraph (m) of this section; and

(*e*) A review of this standard, including appendices.

(2) *Access to training materials.* (i) The employer shall make a copy of this standard and its appendices readily available to all affected employees.

(ii) The employer shall provide, upon request, all materials relating to the employee information and training program to the Assistant Secretary and the Director.

(o) *Signs and labels*—(1) *General.* (i) The employer may use labels or signs required by other statutes, regulations, or ordinances in addition to or in combination with, signs and labels required by this paragraph.

(ii) The employer shall assure that no statement appears on or near any sign or label required by this paragraph which contradicts or detracts from the required sign or label.

(2) *Signs.* (i) The employer shall post signs to clearly indicate all regulated areas. These signs shall bear the legend:

DANGER

1,2-Dibromo-3-chloropropane

(*Insert appropriate trade or common names*)

CANCER HAZARD

AUTHORIZED PERSONNEL ONLY

RESPIRATOR REQUIRED

(3) *Labels.* (i) The employer shall assure that precautionary labels are affixed to all containers of DBCP and of products containing DBCP in the workplace, and that the labels remain affixed when the DBCP or products containing DBCP are sold, distributed, or otherwise leave the employer's workplace. Where DBCP or products containing DBCP are sold, distributed or otherwise leave the employer's workplace bearing appropriate labels required by EPA under the regulations in 40 CFR Part 162, the labels required by this paragraph need not be affixed.

(ii) The employer shall assure that the precautionary labels required by this paragraph are readily visible and legible. The labels shall bear the following legend:

DANGER

1,2-Dibromo-3-chloropropane

CANCER HAZARD

(p) *Recordkeeping*—(1) *Exposure monitoring.* (i) The employer shall establish and maintain an accurate record of all monitoring required by paragraph (f) of this section.

(ii) This record shall include:

(A) The dates, number, duration and results of each of the samples taken, including a description of the sampling procedure used to determine representative employee exposure;

(B) A description of the sampling and analytical methods used;

(C) Type of respiratory protective devices worn, if any; and

(D) Name, social security number, and job classification of the employee monitored and of all other employees whose exposure the measurement is intended to represent.

(iii) The employer shall maintain this record for at least 40 years or the duration of employment plus 20 years, whichever is longer.

(2) *Medical surveillance.* (i) The employer shall establish and maintain an accurate record for each employee subject to medical surveillance required by paragraph (m) of this section.

(ii) This record shall include:

(*a*) The name and social security number of the employee;

(*b*) A copy of the physician's written opinion;

(*c*) Any employee medical complaints related to exposure to DBCP;

(*d*) A copy of the information provided the physician as required by paragraphs (m)(4)(ii) through (m)(4)(iv) of this section; and

(*e*) A copy of the employee's medical and work history.

(iii) The employer shall maintain this record for at least 40 years or the duration of employment plus 20 years, whichever is longer.

(3) *Availability.* (i) The employer shall assure that all records required to be maintained by this section be made available upon request to the Assistant Secretary and the Director for examination and copying.

(ii) The employer shall assure that all employee exposure monitoring records required by this section be made available for examination and copying to affected employees or their designated representatives.

(iii) The employer shall assure that former employees and former employee's designated representatives have access to such records as will indicate the former employee's own exposure to DBCP.

(iv) The employer shall assure that employee medical records required to be maintained by this section be made available, upon request, for examination and copying to the employee or former employee and to a physician or other individual designated by the affected employee or former employee.

(4) *Transfer of records.* (i) If the employer ceases to do business, the successor employer shall receive and retain all records required to be maintained by paragraph (p) of this section for the prescribed period.

(ii) If the employer ceases to do business and there is no successor employer to receive and retain the records for the prescribed period, the employer shall transmit these records by mail to the Director.

(iii) At the expiration of the retention period for the records required to be maintained under paragraph (p) of this section, the employer shall transmit these records by mail to the Director.

(q) *Observation of monitoring*—(1) *Employee observation.* The employer shall provide affected employees, or their designated representatives, with an opportunity to observe any monitoring of employee exposure to DBCP required by this section.

(2) *Observation procedures.* (i) Whenever observation of the measuring or monitoring of employee exposure to DBCP requires entry into an area where the use of protective clothing or equipment is required, the employer shall provide the observer with personal protective clothing or equipment required to be worn by employees working in the area, assure the use of such clothing and equipment, and require the observer to comply with all other applicable safety and health procedures.

(ii) Without interfering with the monitoring or measurement, observers shall be entitled to:

(*a*) Receive an explanation of the measurement procedures;

(*b*) Observe all steps related to the measurement of airborne concentrations of DBCP performed at the place of exposure; and

(*c*) Record the results obtained.

(r) *Appendices.* The information contained in the appendices is not intended, by itself, to create any additional obligations not otherwise imposed or to detract from any existing obligation.

## Appendix A—Substance Safety Data Sheet For DBCP

### I. SUBSTANCE IDENTIFICATION

A. Synonyms and trades names: DBCP; Dibromochloropropane; Fumazone (Dow Chemical Company TM); Nemafume; Nemagon (Shell Chemical Co. TM); Nemaset; BBC 12; and OS 1879.

B. Permissible exposure:

1. *Airborne.* 1 part DBCP vapor per billion parts of air (1 ppb); time-weighted average (TWA) for an 8-hour workday.

2. *Dermal.* Eye contact and skin contact with DBCP are prohibited.

C. Appearance and odor: Technical grade DBCP is a dense yellow or amber liquid with a pungent odor. It may also appear in granular form, or blended in varying concentrations with other liquids.

D. Uses: DBCP is used to control nematodes, very small worm-like plant parasites, on crops including cotton, soybeans, fruits, nuts, vegetables and ornamentals.

### II. HEALTH HAZARD DATA

A. Routes of entry: Employees may be exposed:

1. Through inhalation (breathing);
2. Through ingestion (swallowing);
3. Skin contact; and
4. Eye contact.

B. Effects of exposure:

1. *Acute exposure.* DBCP may cause drowsiness, irritation of the eyes, nose, throat and skin, nausea and vomiting. In addition, overexposure may cause damage to the lungs, liver or kidneys.

2. *Chronic exposure.* Prolonged or repeated exposure to DBCP has been shown to cause sterility in humans. It also has been shown to produce cancer and sterility in laboratory animals and has been determined to constitute an increased risk of cancer in man.

3. *Reporting Signs and Symptoms.* If you develop any of the above signs or symptoms that you think are caused by exposure to DBCP, you should inform your employer.

### III. EMERGENCY FIRST AID PROCEDURES

A. *Eye exposure.* If DBCP liquid or dust containing DBCP gets into your eyes, wash your eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with DBCP.

B. *Skin exposure.* If DBCP liquids or dusts containing DBCP get on your skin, immediately wash using soap or mild detergent and water. If DBCP liquids or dusts containing DBCP penetrate through your clothing, remove the clothing immediately and wash. If irritation is present after washing get medical attention.

C. *Breathing.* If you or any person breathe in large amounts of DBCP, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Do not use mouth-to-mouth. Keep the affected person warm and at rest. Get medical attention as soon as possible.

D. *Swallowing.* When DBCP has been swallowed and the person is conscious, give the person large amounts of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

E. *Rescue.* Notify someone. Put into effect the established emergency rescue procedures. Know the locations of the emergency rescue equipment before the need arises.

### IV. RESPIRATORS AND PROTECTIVE CLOTHING

A. *Respirators.* You may be required to wear a respirator in emergencies and while your employer is in the process of reducing DBCP exposures through engineering controls. If respirators are worn, they must have a National Institute for Occupational Safety and Health (NIOSH) approval label (Older respirators may have a Bureau of Mines Approval label). For effective protection, a respirator must fit your face and head snugly. The respirator should not be loosened or removed in work situations where its use is required. DBCP does not have a detectable odor except at 1,000 times or more above the permissible exposure limit. If you can smell DBCP while wearing a respirator, the respirator is not working correctly; go immediately to fresh air. If you experience difficulty breathing while wearing a respirator, tell your employer.

B. *Protective clothing.* When working with DBCP you must wear for your protection impermeable work clothing provided by your employer. (Standard rubber and neoprene protective clothing do not offer adequate protection).

DBCP must never be allowed to remain on the skin. Clothing and shoes must not be allowed to become contaminated with DBCP, and if they do, they must be promptly removed and not worn again until completely free of DBCP. Turn in impermeable clothing that has developed leaks for repair or replacement.

C. *Eye protection.* You must wear splash-proof safety goggles where there is any pos-

sibility of DBCP liquid or dust contacting your eyes.

V. PRECAUTIONS FOR SAFE USE, HANDLING, AND STORAGE

A. DBCP must be stored in tightly closed containers in a cool, well-ventilated area.

B. If your work clothing may have become contaminated with DBCP, or liquids or dusts containing DBCP, you must change into uncontaminated clothing before leaving the work premises.

C. You must promptly remove any protective clothing that becomes contaminated with DBCP. This clothing must not be reworn until the DBCP is removed from the clothing.

D. If your skin becomes contaminated with DBCP, you must immediately and thoroughly wash or shower with soap or mild detergent and water to remove any DBCP from your skin.

E. You must not keep food, beverages, cosmetics, or smoking materials, nor eat or smoke, in regulated areas.

F. If you work in a regulated area, you must wash your hands thoroughly with soap or mild detergent and water, before eating, smoking or using toilet facilities.

G. If you work in a regulated area, you must remove any protective equipment or clothing before leaving the regulated area.

H. Ask your supervisor where DBCP is used in your work area and for any additional safety and health rules.

VI. ACCESS TO INFORMATION

A. Each year, your employer is required to inform you of the information contained in this Substance Safety Data Sheet for DBCP. In addition, your employer must instruct you in the safe use of DBCP, emergency procedures, and the correct use of protective equipment.

B. Your employer is required to determine whether you are being exposed to DBCP. You or your representative have the right to observe employee exposure measurements and to record the result obtained. Your employer is required to inform you of your exposure. If your employer determines that you are being overexposed, he is required to inform you of the actions which are being taken to reduce your exposure.

C. Your employer is required to keep records of your exposure and medical examinations. Your employer is required to keep exposure and medical data for at least 40 years or the duration of your employment plus 20 years, whichever is longer.

D. Your employer is required to release exposure and medical records to you, your physician, or other individual designated by you upon your written request.

## APPENDIX B—SUBSTANCE TECHNICAL GUIDELINES FOR DBCP

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. Synonyms: 1,2-dibromo-3-chloropropane; DBCP, Fumazone; Nemafume; Nemagon; Nemaset; BBC 12; OS 1879. DBCP is also included in agricultural pesticides and fumigants which include the phrase "Nema———" in their name.

2. Formula: C3H5Br2 Cl.

3. Molecular Weight: 236.

B. Physical Data:

1. Boiling point (760 mm HG): 195C (383F)

2. Specific gravity (water=1): 2.093.

3. Vapor density (air=1 at boiling point of DBCP): Data not available.

4. Melting point: 6C (43F).

5. Vapor pressure at 20C (68F): 0.8 mm Hg

6. Solubility in water: 1000 ppm.

7. Evaporation rate (Butyl Acetate=1): very much less than 1.

8. Appearance and odor: Dense yellow or amber liquid with a pungent odor at high concentrations. Any detectable odor of DBCP indicates overexposure.

II. FIRE EXPLOSION AND REACTIVITY HAZARD DATA

A. Fire

1. Flash point: 170F (77C)

2. Autoignition temperature: Data not available.

3. Flammable limits in air, percent by volume: Data not available.

4. Extinguishing media: Carbon dioxide, dry chemical.

5. Special fire-fighting procedures: Do not use a solid stream of water since a stream will scatter and spread the fire. Use water spray to cool containers exposed to a fire.

6. Unusual fire and explosion hazards: None known.

7. For purposes of complying with the requirements of § 1910.106, liquid DBCP is classified as a Class III A combustible liquid.

8. For the purpose of complying with § 1910.309, the classification of hazardous locations as described in article 500 of the National Electrical Code for DBCP shall be Class I, Group D.

9. For the purpose of compliance with § 1910.157, DBCP is classified as a Class B fire hazard.

10. For the purpose of compliance with § 1910.178, locations classified as hazardous locations due to the presence of DBCP shall be Class I, Group D.

11. Sources of ignition are prohibited where DBCP presents a fire or explosion hazard.

B. Reactivity

1. Conditions contributing to instability: None known.

2. Incompatibilities: Reacts with chemically active metals, such as aluminum, magnesium and tin alloys.

3. Hazardous decomposition products: Toxic gases and vapors (such as HBr, HCl and carbon monoxide) may be released in a fire involving DBCP.

4. Special precautions: DBCP will attack some rubber materials and coatings.

III. SPILL, LEAK AND DISPOSAL PROCEDURES

A. If DBCP is spilled or leaked, the following steps should be taken:

1. The area should be evacuated at once and re-entered only after thorough ventilation.

2. Ventilate area of spill or leak.

3. If in liquid form, collect for reclamation or absorb in paper, vermiculite, dry sand, earth or similar material.

4. If in solid form, collect spilled material in the most convenient and safe manner for reclamation or for disposal.

B. Persons not wearing protective equipment must be restricted from areas of spills or leaks until cleanup has been completed.

C. Waste Disposal Methods:

1. For small quantities of liquid DBCP, absorb on paper towels, remove to a safe place (such as a fume hood) and burn the paper. Large quantities can be reclaimed or collected and atomized in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device. If liquid DBCP is absorbed in vermiculite, dry sand, earth or similar material and placed in sealed containers it may be disposed of in a State-approved sanitary landfill.

2. If in solid form, for small quantities, place on paper towels, remove to a safe place (such as a fume hood) and burn. Large quantities may be reclaimed. However, if this is not practical, dissolve in a flammable solvent (such as alcohol) and atomize in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device. DBCP in solid form may also be disposed in a state-approved sanitary landfill.

IV. MONITORING AND MEASUREMENT PROCEDURES

A. Exposure above the permissible exposure limit.

1. *Eight Hour Exposure Evaluation:* Measurements taken for the purpose of determining employee exposure under this section are best taken so that the average 8-hour exposure may be determined from a single 8-hour sample or two (2) 4-hour samples. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

2. *Monitoring Techniques:* The sampling and analysis under this section may be performed by collecting the DBCP vapor on petroleum based charcoal absorption tubes with subsequent chemical analyses. The method of measurement chosen should determine the concentration of airborne DBCP at the permissible exposure limit to an accuracy of plus or minus 25 percent. If charcoal tubes are used, a total volume of 10 liters should be collected at a flow rate of 50 cc. per minute for each tube. Analyze the resultant samples as you would samples of halogenated solvent.

B. Since many of the duties relating to employee protection are dependent on the results of monitoring and measuring procedures, employers should assure that the evaluation of employee exposures is performed by a competent industrial hygienist or other technically qualified person.

V. PROTECTIVE CLOTHING

Employees should be required to wear appropriate protective clothing to prevent any possibility of skin contact with DBCP. Because DBCP is absorbed through the skin, it is important to prevent skin contact with both liquid and solid forms of DBCP. Protective clothing should include impermeable coveralls or similar fullbody work clothing, gloves, headcoverings, and workshoes or shoe coverings. Standard rubber and neoprene gloves do not offer adequate protection and should not be relied upon to keep DBCP off the skin. DBCP should never be allowed to remain on the skin. Clothing and shoes should not be allowed to become contaminated with the material, and if they do, they should be promptly removed and not worn again until completely free of the material. Any protective clothing which has developed leaks or is otherwise found to be defective should be repaired or replaced. Employees should also be required to wear splash-proof safety goggles where there is any possibility of DBCP contacting the eyes.

VI. HOUSEKEEPING AND HYGIENE FACILITIES

1. The workplace must be kept clean, orderly and in a sanitary condition;

2. Dry sweeping and the use of compressed air is unsafe for the cleaning of floors and other surfaces where DBCP dust or liquids are found. To minimize the contamination of air with dust, vacuuming with either portable or permanent systems must be used. If a portable unit is selected, the exhaust must be attached to the general workplace exhaust ventilation system, or collected within the vacuum unit equipped with high efficiency filters or other appropriate means of contamination removal and not used for other purposes. Units used to collect DBCP must be labeled.

3. Adequate washing facilities with hot and cold water must be provided, and maintained in a sanitary condition. Suitable cleansing agents should also be provided to assure the effective removal of DBCP from the skin.

4. Change or dressing rooms with individual clothes storage facilities must be provided to prevent the contamination of street clothes with DBCP. Because of the hazardous nature of DBCP, contaminated protective clothing must be stored in closed containers for cleaning or disposal.

VII. MISCELLANEOUS PRECAUTIONS

A. Store DBCP in tightly closed containers in a cool, well ventilated area.

B. Use of supplied-air suits or other impervious clothing (such as acid suits) may be necessary to prevent skin contact with DBCP. Supplied-air suits should be selected, used, and maintained under the supervision of persons knowlegeable in the limitations and potential life-endangering characteristics of supplied-air suits.

C. The use of air-conditioned suits may be necessary in warmer climates.

D. Advise employees of all areas and operations where exposure to DBCP could occur.

VIII. COMMON OPERATIONS

Common operations in which exposure to DBCP is likely to occur are: during its production; and during its formulation into pesticides and fumigants.

APPENDIX C—MEDICAL SURVEILLANCE GUIDELINES FOR DBCP

I. ROUTE OF ENTRY

Inhalation; skin absorption

II. TOXICOLOGY

Recent data collected on workers involved in the manufacture and formulation of DBCP has shown that DBCP can cause sterility at very low levels of exposure. This finding is supported by studies showing that DBCP causes sterility in animals. Chronic exposure to DBCP resulted in pronounced necrotic action on the parenchymatous organs (i.e., liver, kidney, spleen) and on the testicles of rats at concentrations as low as 5 ppm. Rats that were chronically exposed to DBCP also showed changes in the composition of the blood, showing low RBC, hemoglobin, and WBC, and high reticulocyte levels as well as functional hepatic disturbance, manifesting itself in a long prothrombin time. Reznik et al. noted a single dose of 100 mg produced profound depression of the nervous system of rats. Their condition gradually improved. Acute exposure also resulted in the destruction of the sex gland activity of male rats as well as causing changes in the estrous cycle in female rats. Animal studies have also associated DBCP with an increased incidence of carcinoma. Olson, et al. orally administered DBCP to rats and mice 5 times per week at experimentally predetermined maximally tolerated doses and at half those doses. As early as ten weeks after initiation of treatment, DBCP induced a high incidence of squamous cell carcinomas of the stomach with metastases in both species. DBCP also induced mammary adenocarcinomas in the female rats at both dose levels.

III. SIGNS AND SYMPTOMS

A. Inhalation: Nausea, eye irritation, conjunctivitis, respiratory irritation, pulmonary congestion or edema, CNS depression with apathy, sluggishness, and ataxia.

B. Dermal: Erythema or inflammation and dermatitis on repeated exposure.

IV. SPECIAL TESTS

A. *Semen analysis:* The following information excerpted from the document "Evaluation of Testicular Function", submitted by the Corporate Medical Department of the Shell Oil Company (exhibit 39-3), may be useful to physicians conducting the medical surveillance program;

In performing semen analyses certain minimal but specific criteria should be met;

1. It is recommended that a minimum of three valid semen analyses be obtained in order to make a determination of an individual's average sperm count.

2. A period of sexual abstinence is necessary prior to the collection of each masturbatory sample. It is recommended that intercourse or masturbation be performed 48 hours before the actual specimen collection. A period of 48 hours of abstinence would follow; then the masturbatory sample would be collected.

3. Each semen specimen should be collected in a clean, widemouthed, glass jar (not necessarily pre-sterilized) in a manner designated by the examining physician. Any part of the seminal fluid exam should be initialed *only after liquifaction* is complete, i.e., 30 to 45 minutes after collection.

4. Semen volume should be measured to the nearest $\frac{1}{10}$ of a cubic centimeter.

5. Sperm density should be determined using routine techniques involving the use of a white cell pipette and a hemocytometer chamber. The immobilizing fluid most effective and most easily obtained for this process is distilled water.

6. Thin, dry smears of the semen should be made for a morphologic classification of the sperm forms and should be stained with either hematoxalin or the more difficult, yet more precise, Papanicolaou technique. Also of importance to record is obvious sperm agglutination, pyospermia, delayed liquifaction (greater than 30 minutes), and hyperviscosity. In addition, pH, using nitrazine paper, should be determined.

7. A total morphology evaluation should include percentages of the following:

a. Normal (oval) forms,

b. Tapered forms,

c. Amorphous forms (include large and small sperm shapes),

d. Duplicated (either heads or tails) forms, and

e. Immature forms.

8. Each sample should be evaluated for sperm *viability* (percent viable sperm moving at the time of examination) as well as sperm *motility* (subjective characterization of "purposeful forward sperm progression" of the majority of those viable sperm analyzed) within two hours after collection, ideally by the same or equally qualified examiner.

B. *Serum determinations:* The following serum determinations should be performed by radioimmuno-assay techniques using National Institutes of Health (NIH) specific antigen or antigen preparations of equivalent sensitivity;

1. Serum follicle stimulating hormone (FSH);

2. Serum luteinizing hormone (LH); and

3. Serum total estrogen (females only).

V. TREATMENT

Remove from exposure immediately, give oxygen or artificial resuscitation if indicated. Contaminated clothing and shoes should be removed immediately. Flush eyes and wash contaminated skin. If swallowed and the person is conscious, induce vomiting. Recovery from mild exposures is usually rapid and complete.

VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. *Other considerations.* DBCP can cause both acute and chronic effects. It is important that the physician become familiar with the operating conditions in which exposure to DBCP occurs. Those with respiratory disorders may not tolerate the wearing of negative pressure respirators.

B. *Surveillance and screening.* Medical histories and laboratory examinations are required for each employee subject to exposure to DBCP. The employer should screen employees for history of certain medical conditions (listed below) which might place the employee at increased risk from exposure.

1. *Liver disease.* The primary site of biotransformation and detoxification of DBCP is the liver. Liver dysfunctions likely to inhibit the conjugation reactions will tend to promote the toxic actions of DBCP. These precautions should be considered before exposing persons with impaired liver function to DBCP.

2. *Renal disease.* Because DBCP has been associated with injury to the kidney it is important that special consideration be given to those with possible impairment of renal function.

3. *Skin desease.* DBCP can penetrate the skin and can cause erythema on prolonged exposure. Persons with pre-existing skin disorders may be more susceptible to the effects of DBCP.

4. *Blood dyscrasias.* DBCP has been shown to decrease the content of erythrocytes, hemoglobin, and leukocytes in the blood, as well as increase the prothrombin time. Persons with existing blood disorders may be more susceptible to the effects of DBCP.

5. *Reproductive disorders.* Animal studies have associated DBCP with various effects on the reproductive organs. Among these effects are atrophy of the testicles and changes in the estrous cycle. Persons with pre-existing reproductive disorders may be at increased risk to these effects of DBCP.

REFERENCES

1. Reznik, Ya. B. and Sprinchan, G. K.: Experimental Data on the Gonadotoxic effect of Nemagon, *Gig. Sanit.*, (6), 1975, pp. 101-102, (translated from Russian).

2. Faydysh, E. V., Rakhmatullaev, N. N. and Varshavskii, V. A.: The Cytotoxic Action of Nemagon in a Subacute Experi-

ment, *Med. Zh. Uzbekistana*, (No. 1), 1970, pp. 64-65, (translated from Russian).

3. Rakhmatullaev, N. N.: Hygienic Characteristics of the Nematocide Nemagon in Relation to Water Pollution Control, *Hyg. Sanit.*, 36(3), 1971, pp. 344-348, (translated from Russian).

4. Olson, W. A. *et al.:* Induction of Stomach Cancer in Rats and Mice by Halogenated Aliphatic Fumigants, *Journal of the National Cancer Institute*, (51), 1973, pp. 1993-1995.

5. Torkelson, T. R. *et al.:* Toxicologic Investigations of 1,2-Dibromo-3-chloropropane, *Toxicology and Applied Pharmacology, 3, 1961 pp. 545-559.*

**§ 1910.1045 Acrylonitrile.**

(a) *Scope and application.* (1) This section applies to all occupational exposures to acrylonitrile (AN), Chemical Abstracts Service Registry No. 000107131, except as provided in paragraph (a)(2) of this section.

(2) This section does not apply to the processing, use, and handling of products fabricated from polyacrylonitrile (PAN) where objective data is reasonably relied upon as to one of the following conditions:

(i) That the material to be processed is not capable of releasing AN in airborne concentrations in excess of 1 ppm under expected conditions of processing, use, and handling which will cause the greatest possible release; or

(ii) That the material to be processed is not a latex or other liquid mixture and will not be heated or melted during the fabrication process.

(3) Where the processing, use and handling of products fabricated from PAN are exempted under this paragraph the employer shall maintain records of the objective data supporting that exemption, as provided in paragraph (q) of this section.

(b) *Definitions.* "Acrylonitrile" or "AN" means acrylonitrile monomer, chemical formula $CH2=CHCN$.

"Action level" means a concentration of AN of 1 ppm averaged over any eight (8)-hour period.

"Assistant Secretary" means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

"Authorized person" means any person specifically authorized by the employer and whose duties require the person to be present in areas where AN concentrations exceed the permissible exposure limit and any person entering this area as a designated representative of employees exercising an opportunity to observe employee exposure monitoring under paragraph (r) of this section.

"Director" means the Director, National Institute for Occupational Safety and Health, U.S. Department of Health, Education, and Welfare, or designee.

"OSHA Area Office" means the Area Office of the Occupational Safety and Health Administration having jurisdiction over the geographic area where the affected workplace is located.

"Polyacrylonitrile" or "PAN" means polyacrylonitrile homopolymer or copolymer, except for materials as exempted under paragraph (a)(2) or of this section.

(c) *Permissible exposure limit.*—(1) *Inhalation.*—(i) *Time-weighted average limit (TWA).* As soon as possible, but no later than thirty (30) days from the effective date of this emergency temporary standard, the employer shall assure that no employee is exposed to an airborne concentration in excess of 2 parts AN per million parts of air (2 ppm), as an 8-hour time-weighted average.

(ii) *Ceiling limit.* As soon as possible, but no later than thirty (30) days from the effective date of this emergency temporary standard, the employer shall assure that no employee is exposed to an airborne concentration in excess of 10 parts AN per million parts of air (10 ppm) as averaged over any 15 minutes during the working day.

(2) *Dermal and eye exposure.* As soon as possible, but no later than thirty (30) days from the effective date of this emergency temporary standard, the employer shall assure that no employee is exposed to skin contact or eye contact with liquid AN, or with PAN.

(d) *Notification of use.* Within thirty (30) days of the effective date of this section or within fifteen (15) days following the introduction of AN into the workplace, every employer who has a workplace where AN is present shall report the following information to the nearest OSHA Area Office for each such workplace: (1) The address and location of each workplace in which AN is present;

(2) A brief description of each process or operation which may result in employee exposure to AN;

(3) The number of employees engaged in each process or operation who may be exposed to AN and an estimate of the frequency and degree of exposure that occurs; and

(4) A brief description of the employer's safety and health program as it relates to limitation of employee exposure to AN.

(e) *Exposure monitoring.*—(1) *General.* Determinations of airborne exposure levels shall be made from air samples that are representative of each employee's exposure to AN over an 8-hour period. (For the purposes of this section, employee exposure is that which would occur if the employee were not using a respirator.)

(2) *Initial monitoring.* As soon as possible, but not later than thirty (30) days after the effective date of this section, each such employer who has a place of employment in which AN is present shall monitor each such workplace and work operation to accurately determine the airborne concentrations of AN to which employees may be exposed. Such monitoring may be done on a representative basis, provided that the employer can demonstrate that these determinations are representative of employee exposures.

(3) *Frequency.* (i) If the monitoring required by this section reveals employee exposure to be below the action level, the employer may discontinue monitoring for that employee.

(ii) If the monitoring required by this section reveals employee exposure to be at or above the action level but below the permissible exposure limits, the employer shall repeat such monitoring for each such employee within three months.

(iii) If the monitoring, required by this section, reveals employee exposure to be in excess of the permissible exposure limits, the employer shall repeat these determinations for each such employee at least monthly. The employer shall continue these monthly measurements until at least two consecutive measurements, taken at least seven (7) days apart, are below the permissible exposure limits, and thereafter the employer shall monitor within three months.

(4) *Additional monitoring.* Whenever there has been a production, process, control, or personnel change which may result in new or additional exposures to AN, or whenever the employer has any other reason to suspect a change which may result in new or additional exposures to AN, additional monitoring which complies with this paragraph shall be conducted.

(5) *Employee notification.* (i) Within five (5) working days after the receipt of monitoring results, the employer shall notify each employee in writing of the results which represent that employee's exposure.

(ii) Whenever the results indicate that the representative employee exposure exceeds the permissible exposure limits, the employer shall include in the written notice a statement that the permissible exposure limits were exceeded and a description of the corrective action being taken to reduce exposure to or below the permissible exposure limits.

(6) *Accuracy of measurement.* The method of measurement shall be accurate, to a confidence level of 95 percent, to within plus or minus 25 percent for concentrations of AN at or above the permissible exposure limits, and to within plus or minus 35 percent for concentrations between the action level and the permissible exposure limits.

(f) *Regulated areas.* [Reserved]

(g) *Methods of compliance.*—(1) *General.* Employee exposures to AN shall be controlled to or below the permissible exposure limits by any practicable combination of engineering controls, work practices, and personal protective devices and equipment, during the effective period of this emergency temporary standard.

NOTE.—Where engineering controls or work practices can reduce employee exposures to AN, it is recommended that they be implemented where practicable, even where they do not themselves reduce employee exposures to, or below the permissible exposure limits. Work practices which can be implemented by the employer to help reduce employee exposures to AN include limiting access to work areas to authorized personnel, prohibiting smoking and consumption of food and beverages in work areas, and establishing good maintenance and housekeeping practices, including the prompt clean-up of spills and repair of leaks.

(2) *Engineering and work-practice control plan.* (i) Within ninety (90) days of the effective date of this emergency temporary standard, the employer shall develop a written plan describing proposed means to reduce employee exposures to AN to the lowest feasible level solely by means of engineering and work-practice controls.

(ii) Written plans required under this paragraph shall be submitted upon request to the Secretary and the Director, and shall be available at the worksite for examination and copying by the Assistant Secretary, Director, and any affected employee or designated representative.

(h) *Respiratory protection.*—(1) *Required use.* The employer shall assure that respirators are used where required under this section to reduce employee exposure to within the permissible exposure limits, and in emergencies.

(2) *Respirator selection.* (i) Where respiratory protection is required or permitted under this section, the employer shall select and provide at no cost to the employee, the appropriate respirator from Table I below, and shall assure that the employee wears the respirator provided. Respirators assigned for higher concentrations may also be used for lower concentrations.

(ii) The employer shall select respirators from among those approved for use with organic vapors by the National Institute for Occupational Safety and Health (NIOSH) under the provisions of 30 CFR Part 11.

TABLE 1.—*Respiratory protection for acrylonitrile (AN)*

| *Concentration of AN or condition of use* | *Respirator type* |
|---|---|
| (a) Less than or equal 20 p/m. | (1) Any chemical cartridge respirator with organic vapor cartridge and half-mask; or (2) Any supplied air respirator with half-mask. |
| (b) Less than or equal to 100 p/m. | (1) Any organic vapor gas mask; or (2) Any supplied air respirator with full facepiece; or (3) Any self-contained breathing apparatus with full facepiece. |
| (c) Less than or equal to 4,000 p/m. | (1) Supplied air respirator in positive pressure mode with full facepiece, helmet, hood, or suit. |
| (d) Less than or equal to 20,000 p/m. | (1) Supplied air respirator and auxiliary self-contained full facepiece in positive pressure mode; or (2) Open circuit self-contained breathing apparatus with full facepiece in positive pressure mode. |
| (e) Emergency entry into unknown concentrations or fire fighting. | (1) Any self-contained breathing apparatus with full facepiece in positive pressure mode. |
| (f) Escape | (1) Any organic vapor gas mask; or (2) Any self-contained breathing apparatus with full facepiece. |

(3) *Respirator program.* (i) The employer shall institute a respiratory protection program in accordance with 29 CFR 1910.134(b), (d), (e), and (f).

(ii) Where air-purifying respirators (chemical cartridge or canister-type gas mask) are used, the air-purifying canister or cartridge(s) shall be replaced prior to the expiration of their service life or at the beginning of each shift, whichever occurs first. A label shall be attached to the cartridge or canister to indicate the date and time at which it is first installed on the respirator.

(iii) The employer shall allow each employee who uses a filter respirator (cartridge or canister) to change the filter elements whenever an increase in breathing resistance is detected and shall maintain an adequate supply of filter elements for this purpose.

(iv) Employees who wear respirators shall be allowed to wash their faces and respirator facepieces to prevent potential skin irritation associated with respirator use.

(i) *Emergency situation.* [Reserved]

(j) *Protective clothing and equipment.*—(1) *Provision and use.* Where eye or skin contact with liquid AN or with PAN may occur, the employer shall provide at no cost to the employee, and assure that employees wear, appropriate protective clothing or other equipment in accordance with §§ 1910.132 and 1910.133 to protect any area of the body which may come in contact with liquid AN or with PAN.

(2) *Cleaning and replacement.* (i) The employer shall clean, launder, maintain, or replace protective clothing and equipment required by this paragraph as needed to maintain their effectiveness. In addition, the employer shall provide clean protective clothing and equipment at least weekly to each affected employee.

(ii) The employer shall assure that the employee removes all protective clothing and equipment at the completion of a workshift, and that an employee whose protective clothing becomes wet with liquid AN removes that clothing promptly to avoid skin contact with the liquid AN.

(iii) The employer shall assure that AN-contaminated protective work clothing and equipment is placed and stored in closable containers which prevent dispersion of AN outside the container.

(iv) The employer shall inform any person who launders or cleans AN-contaminated protective clothing or equipment of the potentially harmful effects of exposure to AN.

(v) The employer shall assure that the containers of contaminated protective clothing and equipment which are to be removed from the workplace for any reason are labeled in accordance with paragraph (p)(3)(ii) of this section and that such label remains affixed when such containers leave the employer's workplace.

(k) *Housekeeping*—(1) *Surface.* (i) All surfaces shall be maintained free of accumulations of liquid of AN and of PAN.

(ii) Dry sweeping and the use of compressed air for the cleaning of floors and other surfaces where liquid AN and PAN are found is prohibited.

(iii) Where vacuuming methods are selected, either portable units or a permanent system may be used.

(A) If a portable vacuum unit is selected, the exhaust shall be attached to the general workplace exhaust ventilation system or collected within the vacuum unit, equipped with high efficiency filters or other appropriate means of contaminant removal, so that AN is not reintroduced into the workplace air; and

(B) Portable vacuum units used to collect AN may not be used for other cleaning purposes and shall be labeled as prescribed by paragraph (p)(3)(ii) of this section.

(iv) Cleaning of floors and other contaminated surfaces may not be performed by washing down with a hose, unless a fine spray has first been laid down.

(2) *Liquids.* Where AN is present in a liquid form, or as a resultant vapor, all containers or vessels containing AN shall be enclosed to the maximum

extent feasible and tightly covered when not in use, with adequate provision made to avoid any resulting potential explosion hazard.

(l) *Waste disposal.* AN and PAN waste, scrap, debris, bags, containers or equipment shall be disposed of in sealed bags or other closed containers which prevent dispersion of AN outside the container, and labelled as prescribed in paragraph (p)(3)(ii) of this section.

(m) *Hygiene facilities and practices.* Where employees are exposed to airborne concentrations of AN above the permissible exposure limits, or where employees are required to wear protective clothing or equipment pursuant to paragraph (j) of this section, or where otherwise found to be appropriate, the facilities required by 29 CFR 1910.141 shall be provided by the employer for the use of those employees, and the employer shall assure that the employees use the facilities provided. Change rooms as specified in § 1910.141(c) are not required where the employer can demonstrate that such facilities, if not already available, cannot be feasibly provided before the expiration of this standard. This provision does not in any way diminish preexisting obligations to provide change rooms.

(n) *Medical surveillance*—(1) *General.* (i) The employer shall institute a program of medical surveillance for each employee who is or will be exposed to AN above the action level. The employer shall provide each such employee with an opportunity for medical examinations and tests in accordance with this paragraph.

(ii) The employer shall assure that all medical examinations and procedures are performed by or under the supervision of a licensed physician, and shall be provided without cost to the employee.

(2) *Initial examinations.* Within thirty (30) days of the effective date of this section, or thereafter at the time of initial assignment, the employer shall provide each affected employee an opportunity for a medical examination, including at least the following elements:

(i) A work history and medical history with special attention to skin, respiratory, and gastrointestinal systems, and those non-specific symptoms, such as headache, nausea, vomiting, dizziness, weakness, or other central nervous system dysfunctions that may be associated with acute or with chronic exposure to AN.

(ii) A physical examination giving particular attention to the central nervous system, gastrointestinal system, respiratory system, skin, and thyroid.

(iii) A 14" x 17" posteroanterior chest X-ray.

(iv) Further tests of the intestinal tract, including fecal occult blood and proctosigmoidoscopy, on all workers 40 years of age or older and to any other affected employees for whom, in the opinion of the physician, such testing would be appropriate.

(3) *Periodic examinations.* [Reserved]

(4) *Interim examinations.* If the employee for any reason develops signs or symptoms commonly associated with exposure to AN, the employer shall provide appropriate examination and emergency medical treatment.

(5) *Information provided to the physician.* The employer shall provide the following information to the examining physician:

(i) A copy of this emergency temporary standard and its appendices;

(ii) A description of the affected employee's duties as they relate to the employee's exposure;

(iii) The employee's representative exposure level; and

(iv) A description of any personal protective equipment used or to be used.

(6) *Physician's written opinion.* (i) The employer shall obtain a written opinion from the examining physician which shall include:

(A) The results of the medical test performed;

(B) The physician's opinion as to whether the employee has any detected medical condition which would place the employee at an increased risk of material impairment of the employee's health from exposure to AN;

(C) Any recommended limitations upon the employee's exposure to AN or upon the use of protective clothing and equipment such as respirators; and

(D) A statement that the employee has been informed by the physician of the results of the medical examination and any medical conditions which require further examination or treatment.

(ii) The employer shall instruct the physician not to reveal in the written opinion specific findings or diagnoses unrelated to occupational exposure to AN.

(iii) The employer shall provide a copy of the written opinion to the affected employee.

(o) *Employee information and training.*—(1) *Training program.* (i) As soon as possible but no later than thirty (30) days from the effective date of this standard, the employer shall institute a training program for all employees where there is occupational exposure to AN and shall assure their participation in the training program.

(ii) The employer shall assure that each employee is informed of the following:

(A) The information contained in Appendices A, B and C;

(B) The quantity, location, manner of use, release or storage of AN and the specific nature of operations which could result in exposure to AN, as well as any necessary protective steps;

(C) The purpose, proper use, and limitations of respirators;

(D) The purpose and a description of the medical surveillance program required by paragraph (n) of this section; and

(E) A review of this standard.

(2) *Access to training materials.* (i) The employer shall make a copy of this standard and its appendices readily available to all affected employees.

(ii) The employer shall provide, upon request, all materials relating to the employee information and training program to the Assistant Secretary and the Director.

(p) *Signs and labels.*—(1) *General.*

(i) The employer may use labels or signs required by other statutes, regulations, or ordinances in addition to, or in combination with, signs and labels required by this paragraph.

(ii) The employer shall assure that no statement appears on or near any sign or label, required by this paragraph, which contradicts or detracts from such effects of the required sign or label.

(2) *Signs.* (i) The employer shall post signs to clearly indicate all workplaces where AN concentrations exceed the permissible exposure limits. The signs shall bear the following legend:

DANGER

ACRYLONITRILE (AN)

CANCER HAZARD

AUTHORIZED PERSONS ONLY

RESPIRATORS REQUIRED

(ii) The employer shall assure that signs required by this paragraph are illuminated and cleaned as necessary so that the legend is readily visible.

(3) *Labels.* (i) The employer shall assure that precautionary labels are affixed to all containers of AN, and to containers of PAN and products fabricated from PAN except for those materials for which objective data is provided as to the conditions specified in (a)(2) of this section. The employer shall assure that these labels remain affixed when the AN, PAN and products fabricated from PAN are sold, distributed or otherwise leave the employer's workplace.

(ii) The employer shall assure that the precautionary labels required by this paragraph are readily visible and legible. The labels shall bear the following legend:

DANGER

CONTAINS ACRYLONITRILE (AN)

CANCER HAZARD

(q) *Recordkeeping.*—(1) *Objective data for exempted operations.* (i) Where the processing, use, and handling of products fabricated from PAN are exempted pursuant to paragraph (a)(2) of this section, the employer shall establish and maintain an accurate record of all objective data reasonably relied upon in support of the exemption.

(ii) This record shall include the following information:

(A) The relevant condition in paragraph (a)(2) upon which exemption is based;

(B) The source of the objective data;

(C) The results of testing and analysis of the material being processed;

(D) A description of the operation exempted; and

(E) Other data relevant to the operation, materials, and processing covered by the exemption.

(iii) The employer shall maintain this record for the duration of the employer's reliance upon such objective data.

(2) *Exposure monitoring.* (i) The employer shall establish and maintain an accurate record of all monitoring required by paragraph (e) of this section.

(ii) This record shall include:

(A) The dates, number, duration, and results of each of the samples taken, including a description of the sampling procedure used to determine representative employee exposure;

(B) A description of the sampling and analytical methods used;

(C) Type of respiratory protective devices worn, if any; and

(D) Name, social security number, and job classification of the employee monitored and of all other employees whose exposure the measurement is intended to represent.

(iii) The employer shall maintain this record for the effective period of this emergency temporary standard, and for any additional period required by the permanent standard.

(3) *Medical surveillance.* (i) The employer shall establish and maintain an accurate record for each employee subject to medical surveillance as required by paragraph (n) of this section.

(ii) This record shall include:

(A) A copy of the physicians' written opinions;

(B) Any employee medical complaints related to exposure to AN;

(C) A copy of the information provided to the physician as required by paragraph (n)(6) of this section; and

(D) A copy of the employee's work history.

(iii) The employer shall assure that this record be maintained for the effective period of this emergency temporary standard, and for any additional period required by the permanent standard.

(4) *Availability.* (i) The employer shall assure that all records required to be maintained by this section be made available upon request to the Assistant Secretary and the Director for examination and copying.

(ii) The employer shall assure that employee exposure measurement records, as required by this section, be made available, upon request, for examination and copying to the affected employee, former employee, or designated representative.

(iii) The employer shall assure that employee medical records required to be maintained by this section, be made available, upon request, for examination and copying to the affected employee or former employee, or to a physician designated by the affected employee, former employee, or designated representative.

(r) *Observation of monitoring.*—(1) *Employee observation.* The employer shall provide affected employees, or their designated representatives, an opportunity to observe any monitoring of employee exposure to AN conducted pursuant to paragraph (e) of this section.

(2) *Observation procedures.* (i) Whenever observation of the monitoring of employee exposure to AN requires entry into an area where the use of protective clothing or equipment is required, the employer shall provide the observer with personal protective clothing or equipment required to be worn by employees working in the area, assure the use of such clothing and equipment, and require the observer to comply with all other applicable safety and health procedures.

(ii) Without interfering with the monitoring, observers shall be entitled:

(A) To receive an explanation of the measurement procedures;

(B) To observe all steps related to the measurement of airborne concentrations of AN performed at the place of exposure; and

(C) To record the results obtained.

(s) *Effective date.* This section shall become effective immediately.

(t) *Appendices.* The information contained in the appendices is not intended, by itself, to create any additional obligations not otherwise imposed or to detract from any existing obligations.

APPENDIX A—SUBSTANCE SAFETY SHEET FOR ACRYLONITRILE

I. SUBSTANCE IDENTIFICATION

A. Substance: Acrylonitrile ($CH_2=CHCN$).

B. Synonyms: Propenenitrile; vinyl cyanide; cyanoethylene; AN; VCN; acrylon; carbacryl; fumigrain; ventox.

C. Acrylonitrile can be found as a liquid or vapor, and can also be found in polymer resins, plastics, polyols, and other polymers having acrylonitrile as a raw or intermediate material.

D. AN is used in the manufacture of acrylic and modacrylic fibers, acrylic plastics and resins, specialty polymers, nitrile rubbers, and other organic chemicals. It has also been used as a fumigant.

E. Appearance and Odor: Colorless to pale yellow liquid with a pungent odor which can only be detected at concentrations above the permissible exposure level, in a range of 13–19 parts AN per million parts of air (13–19 ppm).

F. Permissible Exposure: Exposure may not exceed either:

1. 2 parts AN per million parts of air (2 ppm) averaged over the eight-hour workday; or

2. 10 parts AN per million parts of air (10 ppm) averaged over any 15-minute period in the workday.

3. In addition, skin and eye contact with liquid AN is prohibited.

II. HEALTH HAZARD DATA

A. Acrylonitrile can affect your body if you inhale the vapor (breathing) if it comes in contact with your eyes or skin, or if you swallow it. It may enter your body through your skin.

B. Effects of Overexposure:

1. Short-term Exposure: Acrylonitrile causes eye irritation, nausea, vomiting, headache, sneezing, weakness, and lightheadedness. At high concentrations, the effects of exposure may go on to loss of consciousness and death. When acrylonitrile is held in contact with the skin after being absorbed into shoe leather or clothing, it may produce blisters following several hours of no apparent effect. Unless the shoes or clothing are removed immediately and the area washed, blistering will occur. Usually there is no pain or inflammation associated with blister formation.

2. Long-term Exposure: Acrylonitrile has been shown to cause cancer in laboratory animals and has been associated with higher incidences of cancer in humans. Repeated or prolonged exposure of the skin to acrylonitrile may produce irritation and dermatitis.

3. Reporting Signs and Symptoms: You should inform your employer if you develop any signs or symptoms which may be caused by exposure to acrylonitrile.

III. EMERGENCY FIRST AID PROCEDURES

A. Eye Exposure: If acrylonitrile gets into your eyes, wash your eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

B. Skin Exposure: If acrylonitrile gets on your skin, immediately wash the contaminated skin with water. If acrylonitrile soaks through your clothing, especially your shoes, remove the clothing immediately and

wash the skin with water. If symptoms occur after washing, get medical attention immediately. Thoroughly wash the clothing before re-using. Contaminated leather shoes or other leather articles should be discarded.

C. Inhalation: If you or any other person breathes in large amounts of acrylonitrile, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

D. Swallowing: When acrylonitrile has been swallowed, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

E. Rescue: Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency procedures. Do not become a casualty yourself. Understand your emergency rescue procedures and know the locations of the emergency equipment before the need arises.

F. Special First Aid Procedures: First aid kits containing an adequate supply (at least two dozen) of amyl nitrite pearls (ampules), each containing 0.3 ml, should be maintained at each site where acrylonitrile is used. When a person is suspected of receiving an overexposure to acrylonitrile, immediately remove that person from the contaminated area using established rescue procedures. Contaminated clothing must be removed and the acrylonitrile washed from the skin immediately. Artificial respiration should be started at once if breathing has stopped. If the person is unconscious, amyl nitrite may be used as an antidote by a properly trained individual in accordance with established emergency procedures. Medical aid should be obtained immediately.

IV. RESPIRATORS AND PROTECTIVE CLOTHING

A. Respirators: You may be required to wear a respirator for non-routine activities, in emergencies, and while your employer is in the process of reducing acrylonitrile exposures through engineering controls. If respirators are worn, they must have a Mining Enforcement and Safety Administration (MESA) or National Institute for Occupational Safety and Health (NIOSH) approval label. (Older respirators may have a Bureau of Mines approval label.) For effective protection, respirators must fit your face and head snugly. Respirators should not be loosened or removed in work situations where their use is required.

Acrylonitrile does not have a detectable odor except at levels above the permissible exposure limit. Do not depend on odor to warn you when a respirator cartridge or canister is exhausted. Cartridges or canisters must be changed daily. Reuse of these may allow acrylonitrile to gradually filter through the cartridge and cause exposures which you cannot detect by odor. If you can smell acrylonitrile while wearing a respirator, the respirator is not working correctly. Go immediately to fresh air. If you experience difficulty breathing while wearing a respirator tell your employer.

B. Supplied-air Suits: In some work situations, the wearing of supplied-air suits may be necessary. Your employer should instruct you in their proper use and operation.

C. Protective Clothing: You must wear impervious clothing, gloves, face shield, or other appropriate protective clothing to prevent skin contact with liquid acrylonitrile. Replace or repair impervious clothing that has developed leaks. Where protective clothing is required, your employer is required to provide clean garments to you weekly.

Acrylonitrile should never be allowed to remain on the skin. Clothing and shoes should not be allowed to become contaminated with acrylonitrile, and if they do, the clothing should be promptly removed and laundered or discarded, and the shoes should be discarded. Once acrylonitrile penetrates shoe leather, or other leather articles, the article should not be worn again.

D. Eye Protection: You must wear splash-proof safety goggles in areas where liquid acrylonitrile may contact your eyes. In addition, contact lenses should not be worn in areas where eye contact with acrylonitrile can occur.

V. PRECAUTIONS FOR SAFE USE, HANDLING, AND STORAGE

A. Acrylonitrile is a flammable liquid and its vapors can easily form explosive mixtures in air.

B. Acrylonitrile must be stored in tightly-closed containers in a cool, well-ventilated area, away from heat, sparks, flames, strong oxidizers (especially bromine), strong bases, copper, copper alloys, ammonia, and amines.

C. Sources of ignition such as smoking and open flames are prohibited wherever acrylonitrile is handled, used, or stored in a manner that could create a potential fire or explosion hazard.

D. You should use non-sparking tools when opening or closing metal containers of acrylonitrile, and containers must be bonded and grounded when pouring or transferring liquid acrylonitrile.

E. You must immediately remove any non-impervious clothing that becomes contaminated with acrylonitrile, and this clothing must not be reworn until the acrylonitrile is removed from the clothing.

F. Clothing wet with liquid acrylonitrile can be easily ignited. You must promptly remove this clothing, and it must not be reworn until the acrylonitrile is removed from the clothing.

G. If your skin becomes wet with liquid acrylonitrile, you must promptly and thoroughly wash or shower with soap or mild detergent to remove any acrylonitrile from your skin.

H. You must not keep food, beverages, or smoking materials in areas where acrylonitrile is handled, processed, or stored, nor are you permitted to eat or smoke in these areas.

I. If you handle acrylonitrile, you must wash your hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

J. Fire extinguishers and quick drenching facilities must be readily available, and you should know where they are and how to operate them.

K. Ask your supervisor where acrylonitrile is used in your work area and for any additional plant safety and health rules.

VI. ACCESS TO INFORMATION

A. Each year, your employer is required to inform you of the information contained in this Substance Safety Data Sheet for acrylonitrile. In addition, your employer must instruct you in the proper work-practices for using acrylonitrile, emergency procedures, and the correct use of protective equipment.

B. Your employer is required to determine whether you are being exposed to acrylonitrile. You or your representative has the right to observe employee exposure measurements and to record the results obtained. Your employer is required to inform you of your exposure. If your employer determines that you are being overexposed, he or she is required to inform you of the actions which are being taken to reduce your exposure to within permissible exposure limits.

C. Your employer is required to keep records of your exposures and medical examinations. These records must be kept by the employer for at least the effective period of this emergency temporary standard.

D. Your employer is required to release exposure and medical records to your physician upon your written request.

APPENDIX B—SUBSTANCE TECHNICAL GUIDELINES FOR ACRYLONITRILE

I. PHYSICAL AND CHEMICAL DATA

A. Substance identification:

1. Synonyms: AN; VCN; Vinyl Cyanide; Propenenitrile; Cyanoethylene; Acrylon; Carbacryl; Fumigrain; Ventox.

2. Formula: $CH_2=CHCN$.

3. Molecular Weight: 53.1.

B. Physical Data:

1. Boiling Point (760 mm Hg): 77.3° C (171° F).

2. Specific Gravity (water=1): 0.81 (at 20° C or 68° F).

3. Vapor Density (air=1 at boiling point of acrylonitrile): 1.83.

4. Melting Point: −83° F (−117° F).

5. Vapor Pressure at 20° C (68° F): 83 mm Hg.

6. Solubility in Water. Percent by weight at 20° C (68° F): 7.35.

7. Evaporation Rate (Butyl Acetate=1): 4.54.

8. Appearance and Odor: Colorless to pale yellow liquid with a pungent odor at concentrations above the permissible exposure level. Any detectable odor of acrylonitrile may indicate overexposure.

II. FIRE, EXPLOSION, AND REACTIVITY HAZARD DATA

A. Fire:

1. Flash Point: −1° C (30° F) (open cup).

2. Autoignition Temperature: 481° C (898° F).

3. Flammable limits in air, Percent by volume: Lower: 3; Upper: 17.

4. Extinguishing media: Alcohol foam, carbon dioxide, dry chemical.

5. Special fire-fighting procedures: Do not use a solid stream of water, since the stream will scatter and spread the fire. Use water spray to cool containers exposed to a fire.

6. Unusual fire and explosion hazards: Acrylonitrile is a flammable liquid. Its vapors can easily form explosive mixtures with air. All ignition sources must be controlled where acrylonitrile is handled, used, or stored in a manner that could create a potential fire or explosion hazard. Acrylonitrile vapors are heavier than air and may travel along the ground and be ignited by open flames or sparks at locations remote

from the site at which acrylonitrile is being handled.

7. For purposes of compliance with the requirements of 29 CFR 1910.106, acrylonitrile is classified as a Class IB flammable liquid. For example, 7500 ppm, approximately one-fourth of the lower flammable limit, would be considered to pose a potential fire and explosion hazard.

8. For purposes of compliance with 29 CFR 1910.157, acrylonitrile is classified as a Class B fire hazard.

9. For purposes of compliance with 29 CFR 1910.309, locations classified as hazardous due to the presence of acrylonitrile shall be Class I Group D.

B. Reactivity.

1. Conditions contributing to instability: Acrylonitrile will polymerize when hot, and the additional heat liberated by the polymerization may cause containers to explode. Pure AN may self-polymerize with a rapid build-up of pressure resulting in an explosion hazard. Inhibitors are added to the commercial product to prevent self-polymerization.

2. Incompatibilities: Contact with strong oxidizers (especially bromine) and strong bases may cause fires and explosions. Contact with copper, copper alloys, ammonia, and amines may start serious decomposition.

3. Hazardous decomposition products: Toxic gases and vapors (such as hydrogen cyanide, oxides of nitrogen, and carbon monoxide) may be released in a fire involving acrylonitrile and certain polymers made from acrylonitrile.

4. Special precautions: Liquid acrylonitrile will attack some forms of plastics, rubbers, and coatings. Acrylonitrile monomer should be checked at least weekly to determine inhibitor content.

### III. SPILL, LEAK, AND DISPOSAL PROCEDURES

A. If acrylonitrile is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.

2. The area should be evacuated at once and re-entered only after thorough ventilation.

3. If liquid acrylonitrile, collect for reclamation or absorb in paper, vermiculite, dry sand, earth, or similar material.

4. If acrylonitrile polymer, collect spilled material in the most convenient and safe manner for reclamation or for disposal.

B. Persons not wearing protective equipment should be restricted from areas of spills or leaks until clean-up has been completed.

C. Waste disposal methods: Waste material shall be disposed of in a manner that is not hazardous to employees or to the general population. Spills of acrylonitrile and flushing of such spills shall be channeled for appropriate treatment or collection for disposal. They shall not be channeled directly into the sanitary sewer system. Containers of AN and PAN wastes shall be appropriately labelled. In selecting the method of waste disposal, applicable local, state, and federal regulations should be consulted.

### IV. MONITORING AND MEASUREMENT PROCEDURES

A. Exposure above the Permissible Exposure Limit:

1. Eight-hour exposure evaluation: Measurements taken for the purpose of determining employee exposure under this section are best taken so that the average eight-hour exposure may be determined from a single 8-hour sample or two (2) 4-hour samples. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

2. Ceiling evaluation: Measurements taken for the purpose of determining employee exposure under this section must be taken during periods of maximum expected airborne concentrations of acrylonitrile in the employee's breathing zone. A minimum of three (3) measurements should be taken on one work shift. The highest of all measurement taken is an estimate of the employee's ceiling exposure.

3. Monitoring techniques: The sampling and analysis under this section may be performed by collecting the acrylonitrile vapor on charcoal adsorption tubes or other composition adsorption tubes, with subsequent chemical analysis. Sampling and analysis may also be performed by instruments such as detector tubes certified by NIOSH under 42 CFR Part 84, portable direct-reading instruments, or passive dosimeters, as well as by gas and vapor adsorption tubes. The method of measurement chosen should determine the airborne levels of acrylonitrile to an accuracy of plus or minus 25 percent for concentrations of AN at or above the permissible exposure limit, and to within plus or minus 35 percent for concentrations between the action level and the permissible exposure limits.

4. Survey of operations. OSHA suggests that the employer use a direct-reading instrument, such as a portable infra-red analyzer, or equivalent points-monitoring system, to survey weekly, all operations involving liquid AN to determine points at which AN vapor or liquid may be released into the workplace. A listing of points monitored, together with levels of acrylonitrile detected, if any, shall be prepared from this survey, and the listing shall be displayed prominently in the workplace. As an alternative survey method, grab samples, utilizing vapor collection bags, with subsequent gas chromatographic analysis, can be used for this survey.

B. Since many of the duties relating to employee exposure are dependent on the results of monitoring and measuring procedures, employers shall assure that the evaluation of employee exposures is performed by a competent industrial hygienist or other technically qualified person.

### V. PROTECTIVE CLOTHING

Employees shall be provided with, and required to wear appropriate protective clothing to prevent any possibility of skin contact with liquid AN or PAN. Because acrylonitrile is absorbed through the skin, it is important to prevent skin contact with the liquid. Protective clothing shall include impermeable coveralls or similar full-body work clothing, gloves, head-coverings, and workshoes or shoe coverings, as appropriate to protect areas of the body which may come in contact liquid AN or PAN.

Employers should ascertain that the protective garments are impermeable to acrylonitrile. Non-impermeable clothing and shoes should not be allowed to become contaminated with acrylonitrile. If permeable clothing does become contaminated, it should be promptly removed and not worn again until completely free of the material. If leather footwear or other leather garments become wet from acrylonitrile, they should be replaced and not worn again, due to the ability of leather to absorb acrylonitrile and hold it against the skin. Since there is no pain associated with the blistering, it is essential that the employee be informed of this hazard so that he or she can be protected.

Any protective clothing which has developed leaks or is otherwise found to be defective should be repaired or replaced. Clean protective clothing shall be provided weekly to the employee, and whenever the clothing becomes wet with liquid AN or PAN. Employees are also required to wear splashproof safety goggles where there is any possibility of acrylonitrile contacting the eyes.

### VI. HOUSEKEEPING AND HYGIENE FACILITIES

For purposes of complying with 29 CFR 1910.141, the following items should be emphasized:

A. The workplace should be kept clean, orderly, and in a sanitary condition;

B. Dry sweeping and the use of compressed air is unsafe for the cleaning of floors and other surfaces where liquid AN or PAN may be found;

C. Adequate washing facilities with hot and cold water should be provided, and maintained in a sanitary condition. Suitable cleansing agents should also be provided to assure the effective removal of acrylonitrile from the skin;

D. Change or dressing rooms with individual clothes-storage facilities should be provided to prevent the contamination of street clothes with acrylonitrile. Because of the hazardous nature of acrylonitrile, contaminated protective clothing should be stored in closed containers for cleaning or disposal.

### VII. MISCELLANEOUS PRECAUTIONS

A. Store acrylonitrile in tightly-closed containers in a cool, well-ventilated area, and take the necessary precautions to avoid an explosion hazard.

B. High exposure to acrylonitrile can occur when transferring the liquid from one container to another.

C. Non-sparking tools must be used to open and close metal acrylonitrile containers. These containers must be effectively grounded and bonded prior to pouring.

D. Never store uninhibited acrylonitrile. The inhibitor content shall be determined weekly.

E. Acrylonitrile vapors are not inhibited. They may form polymers and clog vents of storage tanks.

F. Use of supplied-air suits or other impervious coverings may be necessary to prevent skin contact and provide respiratory protection from with acrylonitrile where the concentration of acrylonitrile is unknown or is above the ceiling limit. Supplied-air suits should be selected, used, and maintained under the immediate supervision of persons knowledgeable in the limitations and potential life-endangering characteristics of supplied-air suits.

G. Employers shall advise employees of all areas and operations where exposure to acrylonitrile could occur.

### VIII. COMMON OPERATIONS

Common operations in which exposure to acrylonitrile is likely to occur include the following: Manufacture of the acrylonitrile monomer; synthesis of acrylic fibers, ABS and SAN plastics, resins, nitrile rubber, surface coatings, specialty chemicals, use as a

chemical intermediate, use as a fumigant and in the cyanoethylation of cotton.

### Appendix C—Medical Surveillance Guidelines for Acrylonitrile

#### I. Route of Entry

Inhalation; skin and absorption; ingestion.

#### II. Toxicology

Acrylonitrile vapor is an asphyxiant due to its inhibitory action on metabolic enzyme systems. Animals exposed to 75 or 100 ppm for 7 hours have shown signs of anoxia; in some animals which died at the higher level, cyanomethemoglobin was found in the blood. Two human fatalities from accidental poisoning have been reported; one was caused by inhalation of an unknown concentration of the vapor, and the other was thought to be caused by skin absorption or inhalation. Most cases of intoxication from industrial exposure have been mild, with rapid onset of eye irritation, headache, sneezing, and nausea. Weakness, lightheadedness, and vomiting may also occur. Exposure to high concentrations may produce profound weakness, asphyxia, and death. The vapor is a severe eye irritant. Prolonged skin contact with the liquid may result in absorption with systemic effects, and in the formation of large blisters after a latent period of several hours. Although there is usually little or no pain or inflammation, the affected skin resembles a second-degree thermal burn. Solutions spilled on exposed skin, or on areas covered only by a light layer of clothing, evaporate rapidly, leaving no irritation, or, at the most, mild transient redness. Repeated spills on exposed skin may result in dermatitis due to solvent effects.

Results after one year of a planned two-year animal study on the effects of exposure to acrylonitrile have indicated that rats ingesting as little as 35 ppm in their drinking water develop tumors of the central nervous system. The interim results of this study have been supported by a similar study being conducted by the same laboratory, involving exposure of rats by inhalation of acrylonitrile vapor, which has shown similar types of tumors in animals exposed to 80 ppm.

In addition, the preliminary results of an epidemiological study being performed by duPont on a cohort of workers in their Camden, South Carolina acrylic fiber plant indicate a statistically significant increase in the incidence of colon and lung cancer among employees exposed to acrylonitrile.

#### III. Signs and Symptoms of Acute Overexposure

Asphyxia and death can occur from exposure to high concentrations of acrylonitrile. Symptoms of overexposure include eye irritation, headache, sneezing, nausea and vomiting, weakness, and light-headedness. Prolonged skin contact can cause blisters on the skin, with the appearance of a second degree thermal burn, but with little or no pain. Repeated skin contact may produce scaling dermatitis.

#### IV. Treatment of Acute Overexposure

Remove employee from exposure. Immediately flush eyes with water and wash skin with soap or mild detergent and water. If AN has been swallowed and person is conscious, induce vomiting. Give artificial resuscitation if indicated. More severe cases, such as those associated with loss of consciousness, may be treated by the intravenous administration of sodium nitrite, followed by sodium thiosulfate, although this is not as effective for acrylonitrile poisoning as for inorganic cyanide poisoning.

#### V. Surveillance and Preventive Considerations

A. As noted above, exposure to acrylonitrile has been linked to increase incidence of cancers of the colon and lung in employees of the duPont acrylic fiber plant in Camden, S.C. In addition, the animal testing of acrylonitrile has resulted in the development of cancers of the central nervous system in rats exposed by either inhalation or ingestion. The physician should be aware of the findings of these studies in evaluating the health of employees exposed to acrylonitrile.

Most reported acute effects of occupational exposure to acrylonitrile are due to its ability to cause tissue anoxia and asphyxia. The effects are similar to those caused by hydrogen cyanide. Liquid acrylonitrile can be absorbed through the skin upon prolonged contact. The liquid readily penetrated leather, and will produce burns of the feet if footwear contaminated with acrylonitrile is not removed.

It is important for the physician to become familiar with the operating conditions in which exposure to acrylonitrile may occur. Those employees with skin diseases may not tolerate the wearing of whatever protective clothing may be necessary to protect them from exposure. In addition, those with chronic respiratory disease may not tolerate the wearing of negative-pressure respirators.

B. Surveillance and screening. Medical histories and laboratory examinations are required for each employee subject to exposure to acrylonitrile above the action level. The employer must screen employees for history of certain medical conditions which might place the employee at increased risk from exposure.

1. *Central nervous system dysfunction.* Acute effects of exposure to acrylonitrile generally involve the central nervous system. Symptoms of acrylonitrile exposure include headache, nausea, dizziness, and general weakness. The animal studies cited above suggest possible carcinogenic effects of acrylonitrile on the central nervous system, since rats exposed by either inhalation or ingestion have developed similar CNS tumors.

2. *Respiratory disease.* The duPont data indicate an increased risk of lung cancer among employees exposed to acrylonitrile.

3. *Gastrointestinal disease.* The duPont data indicate an increased risk of cancer of the colon among employees exposed to acrylonitrile. In addition, the animal studies show possible tumorogenic effects on the stomachs of the rats in the ingestion study.

4. *Skin disease.* Acrylonitrile can cause skin burns when prolonged skin contact with the liquid occurs. In addition, repeated skin contact with the liquid can cause dermatitis.

5. *General.* The purpose of the medical procedures outlined in the standard is to establish a baseline for future health monitoring. Persons unusually susceptible to the effects of anoxia or those with anemia would be expected to be at increased risk. In addition to emphasis on the CNS, respiratory and gastrointestinal systems, the cardiovascular system, liver and kidney function should also be stressed.

#### Appendix References

1. Communication from A. C. Clark, Manufacturing Chemists Association (MCA), to Douglas Costle, Environmental Protection Agency, dated April 11, 1977.

2. Norris, J. M., "Status Report on the 2-year Study Incorporating Acrylonitrile in the Drinking Water of Rats" (an MCA-sponsored study done by Dow Chemical), dated Jan. 12, 1977.

3. Quast, J. F., et al, "Toxicity of Drinking Water Containing Acrylonitrile (AN) in Rats: Results After 12 Months" (an MCA-sponsored study done by Dow Chemical), dated March 1977.

4. O'Berg, M. T., "Epidemiologic Study of Workers Exposed to Acrylonitrile: Preliminary Results," duPont Company, May 1977.

5. Kirk-Othmer Encyclopedia of Chemical Technology, 2nd ed. A. Stauden, Executive Editor, p. 319, 1972.

6. American Conference of Governmental Industrial Hygienists "Acrylonitrile," Documentation of the Threshold Limit Values for Substances in Workroom Air (3d Ed., 2d printing), Cincinnati, 1974, p. 6.

7. Manufacturing Chemists Association, Inc., Chemical Safety Data Sheet SD-31, "Acrylonitrile." Washington, D.C., 1974, pp. 16-19.

8. Brieger, H., et al., "Acrylonitrile: Spectrophotometric Determination, Acute Toxicity, and Mechanism of Action," A.M.A. Archive of Industrial Hygiene and Occupational Medicine, 6:128-140, 1952.

9. Wolfsie, J. H., "Treatment of Cyanide Poisoning in Industry," A.M.A. Archives of Industrial Hygiene and Occupational Medicine, 4:417-425, 1951.

10. Hygienic Guide Series: "Acrylonitrile," American Industrial Hygiene Association Journal, 18:78-79, 1957.

11. Patty, F. A., "Industrial Hygiene and Toxicology," Volume II: Toxicology (2d Ed., revised), Interscience Publishing Co., New York, 1963, pp. 1992, 2009-2012.

### § 1910.1046a Exposure to cotton dust in cotton gins.

(a) *Scope and application.* This section applies to the control of employee exposure to cotton dust in cotton gins.

(b) *Definitions.* For the purpose of this section:

"Assistant Secretary" means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee;

"Blow down" means the cleaning of equipment and surface with compressed air;

"Cotton dust" means dust present in the air during the handling or processing of cotton which may contain a mixture of many substances including ground-up plant matter, fiber, bacteria, fungi, soil, pesticides, non-cotton plant matter and other contaminants which may have accumulated with the cotton during the growing, harvesting and subsequent processing or storage periods.

"Director" means the Director of the National Institute for Occupational Safety and Health (NIOSH), U.S.

Department of Health, Education, and Welfare, or designee.

(c) *Work practices.* Each employer shall immediately establish and implement a written program of work practices, which shall minimize cotton dust exposure for each specific job. Where applicable, the following work practices shall be included in the written work practices program:

(1) *General.* (i) All surfaces shall be maintained as free as practicable of accumulations of cotton dust.

(ii) The employer shall inspect, clean, maintain and repair, all engineering control equipment, production equipment and ventilation systems including power sources, ducts, and filtration units of the equipment, and at a minimum, tape or cover leaks in valves, flashing, elbows, and bands on air lines.

(iii) Cotton and cotton waste shall be stacked, sorted, baled, dumped, removed or otherwise handled by mechanical means except where the employer can show that it is infeasible to do so. Where infeasible, the method used for handling cotton and cotton waste shall be the method which most effectively reduces exposure to the lowest level feasible.

(2) *Specific.* (i) Floors and other accessible surfaces contaminated with cotton dust may not be cleaned by the use of compressed air.

(ii) Cleaning of clothing with compressed air is prohibited.

(iii) Floor sweeping shall be performed by a vacuum or with methods designed to minimize dispersal of dust.

(iv) Compressed air "blow-down" cleaning shall be prohibited, except where alternative means are not feasible. Where compressed air "blow-down" is done, respirators shall be worn by the employees performing the "blow-down," and employees in the area whose presence is not required to perform the "blow-down" shall be required to leave the area during this cleaning operation.

(3) *Workpractice plan.* A written workplace plan shall be kept which shall list appropriate schedules for carrying out housekeeping operations, and for cleaning and maintaining dust collection equipment. The plan shall be made available for inspection by the Assistant Secretary.

(d) *Use of Respirators*—(1) *General.* Where the use of respirators is required under this section, the employer shall provide, at no cost to the employee, and assure the use of respirators which comply with the requirements of this paragraph (d).

(2) *Use of respirators.* Respirators shall be used in the following circumstances:

(i) By workers identified by medical surveillance under paragraph (e)(6)(i)(*d*) of this section; or

(ii) During operations such as maintenance and repair activities, in which work practice controls are not feasible; or

(iii) In operations specified under paragraph (c)(2)(iv) of this section.

(3) *Availability upon request.* Respirators shall be made available upon request, to any employee exposed to cotton dust

(4) *Respirator selection.* (i) Where respirators are required under this section, the employer shall select, provide and assure the use of any respirator tested and approved for protection against dust by the National Institute of Occupational Safety and Health (NIOSH) under the provisions of 30 CFR Part 11.

(ii) Where respirators are required by this paragraph, the employer shall provide either any NIOSH approved respirator or at the option of each affected worker, a NIOSH approved powered air purifying respirator with a high efficiency filter.

(5) *Respirator program.* The employer shall institute a respirator program in accordance with § 1910.134 (b), (d), (e), and (f).

(6) *Respirator usage.* (i) The employer shall assure that the respirator used by each employee exhibits minimum facepiece leakage and that the respirator is fitted properly.

(ii) The employer shall allow each employee who uses a filter respirator to change the filter elements whenever an increase in breathing resistance is detected by the employee, and shall maintain an adequate supply of filter elements for this purpose.

(iii) The employer shall allow employees who wear respirators to wash their face and respirator facepiece to prevent skin irritation associated with respirator use.

(e) *Medical surveillance*—(1) *General.* (i) Each employer who has an operating gin in which cotton dust is present shall institute a program of medical surveillance for all employees exposed to cotton dust.

(ii) The employer shall assure that all medical examinations and procedures are performed by or under the supervision of a licensed physician, and are provided without cost to the employee.

(iii) Persons other than licensed physicians, who administer the pulmonary function testing required by this section, shall complete a NIOSH approved training course in spirometry.

(2) *Initial examinations.* For each ginning season, at the time of initial assignment, the employer shall provide each employee who is or may be exposed to cotton dust, with an opportunity for medical surveillance that shall include:

(i) A medical history;

(ii) The standardized questionnaire in Appendix B; and

(iii) A pulmonary function measurement, including a determination of forced vital capacity (FVC) and forced expiratory volume in 1 second ($FEV_1$), and the percentage that the measured values of FEV and FVC differ from the predicted values, using the standard tables in Appendix C.

(iv) Based upon the questionnaire results, each employee shall be graded according to Schilling's byssinosis classification system.

(3) *Mid-season retest.* The determinations required under paragraph (e)(2) of this section shall be made again for each employee after at least 14 days of employment and before the termination of employment for the season. The determinations shall be made following at least 24 hours or 1 working day after previous exposure to cotton dust. The pulmonary function tests shall be repeated during the shift, no sooner than 4 and no more than 10 hours after the beginning of the work shift; and, in any event, no more than 1 hour after cessation of exposure.

(4) *Periodic examinations.* (i) The employer shall provide the medical surveillance under this paragraph (e) annually.

(ii) A comparison shall be made between the current examination results and those of previous examinations and a determination made by the physician as to whether there has been a significant change.

(iii) An employee whose $FEV_1$ is less than 60 percent of the predicted value shall be referred to a physician for a detailed pulmonary examination.

(5) *Information provided to the physician.* The employer shall provide the following information to the examining physician:

(i) A copy of this regulation and its Appendices;

(ii) A description of the affected employee's duties as they relate to the employee's exposure;

(iii) A description of any personal protective equipment used or to be used; and

(iv) Information from previous medical examinations of the affected employee which is not readily available to the examining physician.

(6) *Physician's written opinion.* (i) The employer shall obtain and furnish the employee with a copy of the written opinion from the examining physician containing the following:

(*a*) The results of the medical examination and tests, including any determinations made under paragraph (e)(4)(ii) of this section.

(*b*) The physician's opinion as to whether the employee has any detected medical conditions which would place the employee at increased risk of

material impairment of the employee's health from exposure to cotton dust;

(c) The physician's recommended limitations upon the employee's exposure to cotton dust or upon the employee's use of respirators;

(d) The physician's recommendations for the employee's use of a respirator where dust effects could be suppressed by respirator use;

(e) A statement that the employee has been informed by the physician of the results of the medical examination and any medical conditions which require further examination or treatment.

(ii) The written opinion obtained by the employer shall not reveal specific findings or diagnoses unrelated to occupational exposure.

(7) *Spanish speaking employees.* An employer whose workforce consists of a significant percentage of Spanish speaking workers who cannot communicate effectively in English shall provide bi-lingual administration of the medical surveillance requirements, including use of the Spanish questionnaire provided in Appendix B.

(8) *Non-duplication of medical surveillance.* (i) During any one ginning season, an employer is not required to provide medical surveillance as described in this paragraph (f) of this section for any employee who can demonstrate that both the background medical surveillance and the mid-season retest required by paragraph (e) of this section were administered during that ginning season while in the employment of another gin employer.

(ii) If an employee can demonstrate that the background medical surveillance has been administered but not the mid-season retest, the employer shall provide the mid-season medical retest of paragraph (e)(3) of this section, and comply with provisions of paragraphs (e)(4)—(e)(6) of this section. Where the employer is administering only the mid-season retest, the employer shall provide the mid-season retest after at least 14 days of employment in his gin and before termination of employment for the season.

(iii) For purposes of this section, where the employer does not administer any medical surveillance, the employer shall be satisfied that an employee has undergone the medical surveillance required under paragraphs (e)(1) to (e)(3) of this section upon receipt of written notification from the employer who administered the test, or upon receipt by the physician supervising the program, of a copy of the results of medical surveillance.

(f) *Employee education and training.*—(1) *Training program.* (i) Each employer who operates an active gin shall institute a training program for all his employees, prior to initial assignment, and shall assure that each employee is informed of the following:

(a) The specific nature of the operations which could result in exposure to cotton dust;

(b) The measures, including work practices, required by paragraph (c) of this section, necessary to protect the employee from excess exposures;

(c) The purpose, proper use and limitations of respirators required by paragraph (d) of this section;

(d) The purpose for and a description of the medical surveillance program required by paragraph (e) of this section; and other information which will aid exposed employees in understanding the hazards of cotton dust exposure; and

(e) The contents of this standard and its appendices.

(2) *Access to training materials.* (i) Each employer shall post a copy of this section with its Appendices in a public location at the workplace, and shall, upon request, make copies available to employees.

(ii) The employer shall provide all materials relating to the employee training and information program to the Assistant Secretary and the Director upon request.

(iii) An employer whose workforce consists of a significant percentage of Spanish speaking employees who cannot communicate effectively in English shall provide bi-lingual administration of the provisions of this section.

(iv) In addition to the information required by paragraph (f)(1), the employer shall include as part of his training program and distribute to employees any materials pertaining to the Occupational Safety and Health Act, the regulations issued pursuant to that Act, and to this cotton dust standard which are made available by the Assistant Secretary.

(g) *Signs.*—(1) The employer shall post the following warning sign in each work area where there is potential exposure to cotton dust:

WARNING:
COTTON DUST WORK AREA MAY CAUSE ACUTE OR DELAYED LUNG INJURY (BYSSINOSIS).

(2) An employer whose workforce consists of a significant percentage of Spanish-speaking employees who cannot communicate effectively in English shall provide bilingual versions of the sign required by paragraph (g)(1) of this section.

(h) *Recordkeeping.*—(1) *Medical surveillance.* (i) The employer shall establish and maintain an accurate medical record for each employee subject to medical surveillance required by paragraph (e) of this section.

(ii) The record shall include:

(*a*) The name, social security number and description of the duties of the employee;

(*b*) A copy of the medical surveillance results including the medical history, questionnaire responses, results of all tests and the physician's recommendation;

(*c*) A copy of the physician's written opinion;

(*d*) Any employee medical complaints related to exposure to cotton dust;

(*e*) The type of protective devices worn, and length of time worn;

(*f*) A copy of this standard and its appendices, except that the employer may keep one copy of the standard and its appendices for all employees: *Provided,* That he references the standard in the medical surveillance records of each employee.

(iii) The employer shall maintain this record for at least 10 years.

(2) *Availability.* (i) The employer shall make available upon request all records required to be maintained by paragraph (h) of this section to the Assistant Secretary and the Director for examination and copying.

(ii) The employer shall make available an employee's medical records required by this section, for examination and copying, to the affected employee or former employee or to a physician or other individual designated by such affected employee or former employee.

(3) *Transfer of records.* (i) Whenever the employer ceases to do business, the successor employer shall receive and retain all records required to be maintained by paragraph (h) of this section.

(ii) Whenever the employer ceases to do business, and there is no successor employer to receive and retain the records for the prescribed period, these records shall be transmitted to the Director.

(iii) At the expiration of the retention period for the records required to be maintained by this section, the employer shall notify the Director at least 3 months prior to the disposal of such records and shall transmit those records to the Director if he requests them within that period.

(i) *Effective date.* This standard shall become effective on September 4, 1978 except for provisions requiring medical surveillance and respirators for employees who are at an increased exposure to cotton dust which shall become effective on September 4, 1979.

(j) *Appendices.* (1) Appendices to this section are incorporated as part of this section and the contents of these appendices are mandatory.

APPENDIX A.—RECOMMENDATIONS FOR CLASSIFICATION AND RESPIRATORY USE OF WORKERS EXPOSED TO COTTON DUST IN GINS

| Functional severity | FEV 1 (percent of predicted) | FEV 1 (percent) |
|---|---|---|
| P0 | Greater than 80 (no evidence of chronic ventilatory impairment). | (a) −4 to 0; or more.<br>(b) −9 to −5 or more.<br>(c) −10 or more. |
| P1 | 60–79 (evidence of slight to moderate irreversible impairment of ventilatory capacity). | (a) −4 to 0; or more.<br>(b) −5 or more. |
| P2 | Less than 60 (evidence of moderate to severe irreversible impairment of ventilatory capacity). | ..... |

NOTE.—These recommendations are generally accepted criteria for classification and management of workers exposed to cotton dust. Since medical removal provisions are not included in the standard, OSHA believes them to constitute equally useful criteria for the physician to use in determining whether a gin worker is suffering any degree of functional severity which calls for respiratory protection.

Although these criteria are advisory, a worker who falls in the P2 category of functional severity shall be sent to a pulmonary physician according to § 1910.1046a(e)(4)(iii).

[4510-26-C]

# APPENDIX B-1
# RESPIRATORY QUESTIONNAIRE

## A. IDENTIFICATION DATA

PLANT_____ SOCIAL SECURITY NO. _____
DAY MONTH (figures) YEAR (last 2 digits)

NAME_____ DATE OF INTERVIEW_____
(Surname)

_____ DATE OF BIRTH_____
(First Names) M F

ADDRESS_____ AGE_____(8,9) SEX_____(10)

_____ RACE [W] [N] [IND.] [OTHER] (11)

INTERVIEWER: 1 2 3 4 5 6 7 8 (12)

WORK SHIFT: 1st_____ 2nd_____ 3rd_____(13) STANDING HEIGHT_____(14,15)

PRESENT WORK AREA WEIGHT_____(16,18)

If working in more than one specified work area, X area where most of the work shift is spent. If "other," but spending 25% of the work shift in one of the specified work areas, classify in that work area. If carding department employee, check area within that department where most of the work shift is spent (if in doubt, check "throughout"). For work areas such as spinning and weaving where many work rooms may be involved, be sure to check the specific work room to which the employee is assigned – if he works in more than one work room within a department classify as 7 (all) for that department.

| | Workroom Number | (19) Open | (20) Pick | Area | (21) Card #1 | (22) #2 | (23) Spin | (24) Wind | (25) Twist | (26) Spool | (27) Warp | (28) Slash | (29) Weave | (30) Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT RISK (cotton & cotton blend) | 1 | | | Cards | | | | | | | | | | |
| | 2 | | | Draw | | | | | | | | | | |
| | 3 | | | Comb | | | | | | | | | | |
| | 4 | | | Rove | | | | | | | | | | |
| | 5 | | | Thru Out | | | | | | | | | | |
| | 6 | | | | | | | | | | | | | |
| | 7 (all) | | | | | | | | | | | | | |
| Control (synthetic & wool) | 8 | | | | | | | | | | | | | |
| Ex-Worker (cotton) | 9 | | | | | | | | | | | | | |

Use actual wording of each question. Put X in appropriate square after each question. When in doubt record 'No'. When no square, circle appropriate answer.

**B. COUGH**

Do you usually cough first thing in the morning? (on getting up)† Yes___ No___ (31)
(Count a cough with first smoke or on "first going out of doors." Exclude clearing throat or a single cough.)

Do you usually cough during the day or at night? Yes___ No___ (32)
(Ignore an occasional cough.)

If 'Yes' to either question (31-32):

Do you cough like this on most days for as much as three months a year? Yes___ No___ (33)

Do you cough on any particular day of the week? Yes___ No___ (34)

(1) (2) (3) (4) (5) (6) (7)

If 'Yes': Which day? Mon. Tues. Wed. Thur. Fri. Sat Sun. (35)

---

**C. PHLEGM** or alternative word to suit local custom.

Do you usually bring up any phlegm from your chest first thing in the morning? (Count phlegm with the first smoke or on "first going out of doors." Exclude phlegm from the nose. Count swallowed phlegm.) (on getting up)† Yes___ No___ (36)

Do you usually bring up any phlegm from your chest during the day or at night? (Accept twice or more.) Yes___ No___ (37)

If 'Yes' to either question (36) or (37):

Do you bring up phlegm like this on most days for as much as three months each year? Yes___ No___ (38)

If 'Yes' to question (33) or (38):

How long have you had this phlegm? (cough) (Write in number of years (39)

(1) ☐ 2 years or less
(2) ☐ More than 2 years-9 years
(3) ☐ 10-19 years
(4) ☐ 20+ years

†These words are for subjects who work at night

---

**D. CHEST ILLNESSES**

In the past three years, have you had a period of (increased) †cough and phlegm lasting for 3 weeks or more? (40)

(1) ☐ No
(2) ☐ Yes, only one period
(3) ☐ Yes, two or more periods

†For subjects who usually have phlegm

During the past 3 years have you had any chest illness which has kept you off work, indoors at home or in bed? (For as long as one week, flu?) Yes___ No___ (41)

If 'Yes' to (41): Did you bring up (more) phlegm than usual in any of these illnesses? Yes___ No___ (42)

If 'Yes' to (42): During the past three years have you had:
Only one such illness with increased phlegm? (1) ☐ (43)
More than one such illness: (2) ☐ (44)

Br. Grade___

E. TIGHTNESS

Does your chest ever feel tight or your breathing become difficult?_____Yes_____ No_____(45)

Is your chest tight or your breathing difficult on any particular day of the week? (after a week or 10 days away from the mill)_____Yes_____No_____(46)

If 'Yes': Which day? Mon. (3) Tues. (4) Wed. (5) Thur. (6) Fri. (7) Sat. (8) Sun. (47)

(1) Sometimes (2) Always

If 'Yes' Monday: At what time on Monday does your chest feel tight or your breathing difficult? 1 ☐ Before entering the mill (48)

2 ☐ After entering the mill

(Ask only if NO to Question (45)

In the past, has your chest ever been tight or your breathing difficult on any particular day of the week?_____Yes_____No_____(49)

If 'Yes': Which day? Mon. (3) Tues. (4) Wed. (5) Thur. (6) Fri. (7) Sat. (8) Sun. (50)

(1) Sometimes (2) Always

F. BREATHLESSNESS

If disabled from walking by any condition other than heart or lung disease put "X" here and leave questions (52-60) unasked. ☐ (51)

Are you ever troubled by shortness of breath, when hurrying on the level or walking up a slight hill?_____Yes_____No_____(52)

If 'No', grade is 1. If Yes', proceed to next question

Do you get short of breath walking with other people at an ordinary pace on the level?_____Yes_____No_____(53)

If 'No', grade is 2. If 'Yes', proceed to next question

Do you have to stop for breath when walking at your own pace on the level?_____Yes_____No_____(54)

If 'No', grade is 3. If 'Yes', proceed to next question

Are you short of breath on washing or dressing?_____Yes_____No_____(55)

If 'No', grade is 4. If 'Yes', grade is 5.

Dyspnea Grd._____(56)

ON MONDAYS:

Are you ever troubled by shortness of breath, when hurrying on the level or walking up a slight hill?_____Yes_____No_____(57)

If 'No', grade is 1. If 'Yes', proceed to next question

Do you get short of breath walking with other people at an ordinary pace on the level?_____Yes_____No_____(58)

If 'No', grade is 2. If 'Yes', proceed to next question

Do you have to stop for breath when walking at your own pace on the level?_____Yes_____No_____(59)

If 'No', grade is 3. If 'Yes', proceed to next question

Are you short of breath on washing or dressing?_____Yes_____No_____(60)

If 'No', grade is 4. If 'Yes', grade is 5

B. Grd._____(61)

G. OTHER ILLNESSES AND ALLERGY HISTORY

Do you have a heart condition for which you are under a doctor's care? ____ Yes ____ No ____ (62)

Have you ever had asthma? Yes No (63)

If 'Yes', did it begin: (1) ☐ Before age 30

(2) ☐ After age 30

If 'Yes' before 30: did you have asthma before ever going to work in a textile mill? ____ Yes ____ No ____ (64)

Have you ever had hay fever or other allergies (other than above)? ____ Yes ____ No ____ (65)

H. TOBACCO SMOKING*

Do you smoke?

Record 'Yes' if regular smoker up to one month ago. (Cigarettes, cigar or pipe) ____ Yes ____ No ____ (66)

If 'No' to (63).

Have you ever smoked? (Cigarettes, cigars, pipe. Record 'No' if subject has never smoked as much as one cigarette a day, or 1 oz. of tobacco a month, for as long as one year.) ____ Yes ____ No ____ (67)

If 'Yes' to (63) or (64); what have you smoked and for how many years? (Write in specific number of years in the appropriate square)

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | |
|---|---|---|---|---|---|---|---|---|---|---|
| Years | (<5) | (5-9) | (10-14) | (15-19) | (20-24) | (25-29) | (30-34) | (35-39) | (>40) | |
| Cigarettes | | | | | | | | | | (68) |
| Pipe | | | | | | | | | | (69) |
| Cigars | | | | | | | | | | (70) |

If cigarettes, how many packs per day? (Write in number of cigarettes)

(1) ☐ less than 1/2 pack (71)
(2) ☐ 1/2 pack, but less than 1 pack
(3) ☐ 1 pack, but less than 1-1/2 packs
(4) ☐ 1-1/2 packs or more

Number of pack years: ____ (72,73)

If an ex-smoker (cigarettes, cigar or pipe), how long since you stopped? ____ (74)
(Write in number of years)

(1) ☐ 0-1 year
(2) ☐ 1-4 years
(3) ☐ 5-9 years
(4) ☐ 10+ years

*Have you changed your smoking habits since last interview? If yes, specify what changes.

I. OCCUPATIONAL HISTORY**

Have you ever worked in: A foundry? (As long as one year) ____ Yes ____ No ____ (75)

Stone or mineral mining, quarrying or processing? (As long as one year) ____ Yes ____ No ____ (76)

Asbestos milling or processing? (Ever) ____ Yes ____ No ____ (77)

Other dusts, fumes or smoke? If yes, specify: ____ Yes ____ No ____ (78)

Type of exposure ____

Length of exposure ____

**Ask only on first interview.

At what age did you first go to work in a textile mill? (Write in specific age in appropriate square).

| (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|
| <20 | 20-24 | 25-29 | 30-34 | 35-39 | 40+ |
| | | | | | |

When you first worked in a textile mill, did you work with (1) ☐ Cotton or cotton blend (79)

(2) ☐ Synthetic or wool (80)

APPENDIX. B-II

Respiratory Questionnaire

Non-Textile Workers for the
Cotton Industry

Identification No. Interviewer Code

Location Date of Interview

## A. IDENTIFICATION

| 1. NAME (Last) (First) (Middle Initial) | 3. PHONE NUMBER AREA CODE ( ) NO. | 4. SOCIAL SECURITY # (optional see below) |
|---|---|---|
| 2. CURRENT ADDRESS (Number, Street, or Rural Route, City or Town, County, State, Zip Code) | 5. BIRTHDATE (Mo., Day, Yr.) | 6. AGE LAST BIRTHDAY |
| | 7. SEX<br>1 ☐ Male 2 ☐ Female | |
| | 8. ETHNIC GROUP OR ANCESTRY<br>1. ☐ White, not of Hispanic Origin<br>2. ☐ Black, not of Hispanic Origin<br>3. ☐ Hispanic<br>4. ☐ American Indian or Alaskan Native<br>5. ☐ Asian or Pacific Islander<br>6. ☐ Other: _____ | |

| 9. STANDING HEIGHT | 10. WEIGHT | 11. WORK SHIFT |
|---|---|---|
| _____ (cm) | _____ | 1st ☐ 2nd ☐ 3rd ☐ |

12. PRESENT WORK AREA

Please indicate primary assigned work area and percent of time spent at that site. If at other locations, please indicate and note percent of time for each.

| | |
|---|---|
| PRIMARY WORK AREA | |
| SPECIFIC JOB | |

13. APPROPRIATE INDUSTRY

1 ☐ Garnetting 3 ☐ Cotton Warehouse 5 ☐ Cotton Classification

2 ☐ Cottonseed Oil Mill 4 ☐ Utilization 6 ☐ Cotton Ginning

(Furnishing your Social Security number is voluntary. Your refusal to provide this number will not affect any right, benefit, or privilege to which you would be entitled if you did provide your Social Security number. Your Social Security number is being requested since it will permit use in future determinations in statistical research studies.)

B. OCCUPATIONAL HISTORY TABLE

Complete the following table showing the entire work history of the individual from present to initial employment. Sporadic, part-time periods of employment, each of no significant duration, should be grouped if possible.

| INDUSTRY AND LOCATION | TENURE OF EMPLOYMENT | | SPECIFIC OCCUPATION | AVERAGE NO. DAYS WORKED PER WEEK | HAZARDOUS HEALTH EXPOSURE ASSOCIATED WITH WORK | | |
|---|---|---|---|---|---|---|---|
| | FROM 19__ | TO 19__ | | | YES | NO | IF YES, DESCRIBE |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

## C. SYMPTOMS

Use actual wording of each question. Put X in appropriate square after each question. When in doubt record "No".

COUGH.

1. Do you usually cough first thing in the morning? (on getting up)* (Count a cough with first smoke or on "first going out of doors". Exclude clearing throat or a single cough.) 1 ☐ Yes 2 ☐ No

2. Do you usually cough during the day or at night? (Ignore an occasional cough.) 1 ☐ Yes 2 ☐ No

If YES to either question 1 or 2:

3. Do you cough like this on most days for as much as three months a year? 1 ☐ Yes 2 ☐ No 9 ☐ NA

4. Do you cough on any particular day of the week? 1 ☐ Yes 2 ☐ No

If YES:

5. Which day? Mon. Tue. Wed. Thur. Fri. Sat. Sun. _____

PHLEGM

6. Do you usually bring up any phlegm from your chest first thing in the morning? (on getting up)* (Count phlegm with the first smoke or on "first going out of doors." Exclude phlegm from the nose. Count swallowed phlegm.) 1 ☐ Yes 2 ☐ No

7. Do you usually bring up any phlegm from your chest during the day or at night? (Accept twice or more.) 1 ☐ Yes 2 ☐ No

If YES to either question 6 or 7:

8. Do you bring up phlegm like this on most days for as much as three months each year? 1 ☐ Yes 2 ☐ No

If YES to question 3 or 8:

9. How long have you had this phlegm? (cough) (Write in number of years)

(1) ☐ 2 years or less
(2) ☐ More than 2 years - 9 years
(3) ☐ 10-19 years
(4) ☐ 20+ years

*These words are for subjects who work at night

CHEST ILLNESS

10. In the past three years, have you had a period of (increased) cough and phlegm lasting for 3 weeks or more?
(1) ☐ No
(2) ☐ Yes, only one period
(3) ☐ Yes, two or more periods

For subjects who usually have phlegm:

11. During the past 3 years have you had any chest illness which has kept you off work, indoors at home or in bed? (For as long as one week, flu?) 1 ☐ Yes 2 ☐ No

If YES to 11:

12. Did you bring up (more) phelgm than usual in any of these illnesses? 1 ☐ Yes 2 ☐ No

If YES to 12: During the past three years have you had:

13. Only one such illness with increased phelgm? 1 ☐ Yes 2 ☐ No

14. More than one such illness: 1 ☐ Yes 2 ☐ No

Br. Brade _____

TIGHTNESS

15. Does your chest ever feel tight or your breathing become difficult? 1 ☐ Yes 2 ☐ No

16. Is your chest tight or your breathing difficult on any particular day of the week? (after a week or 10 days away from the mill) 1 ☐ Yes 2 ☐ No

17. If YES, Which day? Mon. (1) Tues. (2) Wed. (3) Thur. (4) Fri. (5) Sat. (6) Sun (7)
(1) Sometimes (2) Always

18. If YES Monday: At what time on Monday does your chest feel tight or your breathing difficult?
☐ Before entering mill
☐ After entering mill

(ASK ONLY IF NO TO QUESTION 15)

19. In the past, has your chest ever been tight or your breathing difficult on any particular day of the week? 1 ☐ Yes 2 ☐ No

20. If YES, Which day? Mon. (1) Tues. (2) Wed. (3) Thur. (4) Fri. (5) Sat. (6) Sun. (7)
(1) Sometimes (2) Always

BREATHLESSNESS

21. If disabled from walking by any condition other than heart or lung disease put "X" in the space and leave questions (22-30) unasked. ☐

22. Are you ever troubled by shortness of breath, when hurrying on the level or walking up a slight hill? 1 ☐ Yes 2 ☐ No

If NO, grade is 1. If YES, proceed to next question

23. Do you get short of breath walking with other people at an ordinary pace on the level? 1 ☐ Yes 2 ☐ No

If NO, grade is 2. If YES, proceed to next question

24. Do you have to stop for breath when walking at your own pace on the level? 1 ☐ Yes 2 ☐ No

If NO, grade is 3. If YES, proceed to next question

25. Are you short of breath on washing or dressing? 1 ☐ Yes 2 ☐ No

If NO, grade is 4. If YES, grade is 5.

26. Dyspnea Grd. _____

ON MONDAYS:

27. Are you ever troubled by shortness of breath, when hurrying on the level or walking up a slight hill? 1 ☐ Yes 2 ☐ No

If NO, grade is 1. If YES, proceed to next question

28. Do you get short of breath walking with other people at an ordinary pace on the level? 1 ☐ Yes 2 ☐ No

If NO, grade is 2, If YES, proceed to next question

29. Do you have to stop for breath when walking at your own pace on the level? 1 ☐ Yes 2 ☐ No

If NO, grade is 3. If YES, proceed to next question

30. Are you short of breath on washing or dressing? 1 ☐ Yes 2 ☐ No

If NO, grade is 4. If YES, grade is 5

31. B. Grd. _____

OTHER ILLNESSES AND ALLERGY HISTORY

32. Do you have a heart condition for which you are under a doctor's care? 1 ☐ Yes 2 ☐ No

OTHER ILLNESSES AND ALLERGY HISTORY CONTINUED:

33. Have you ever had asthma? 1 ☐ Yes 2 ☐ No

If yes, did it begin: (1) Before age 30 ☐

(2) After age 30 ☐

34. If yes before 30: did you have asthma before ever going to work in a textile mill? 1 ☐ Yes 2 ☐ No

35. Have you ever had hay fever or other allergies (other than above)? 1 ☐ Yes 2 ☐ No

TOBACCO SMOKING

36. Do you smoke? Record Yes if regular smoker up to one month ago. (Cigarettes, cigar or pipe) 1 ☐ Yes 2 ☐ No

If NO to (33).

37. Have you ever smoked? (Cigarettes, cigars, pipe. Record NO if subject has never smoked as much as one cigarette a day, or 1 oz. of tobacco a month, for as long as one year.) 1 ☐ Yes 2 ☐ No

If Yes to (33) or (34); what have you smoked for how many years? (Write in specific number of years in the appropriate square)

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| Years | (<5) | (5-9) | (10-14) | (15-19) | (20-24) | (25-29) | (30-34) | (35-39) | (>40) |
| 38. Cigarettes | | | | | | | | | |
| 39. Pipe | | | | | | | | | |
| 40. Cigars | | | | | | | | | |

41. If cigarettes, how many packs per day? Write in number of cigarettes _____

☐ Less than 1/2 pack
☐ 1/2 pack, but less than 1 pack
☐ 1 pack, but less than 1 1/2 packs
☐ 1-1/2 packs or more

42. Number of pack years: _____

43. If an ex-smoker (cigarettes, cigar or pipe), how long since you stopped? (Write in number of years.) _____

☐ 0-1 year
☐ 1-4 years
☐ 5-9 years
☐ 10+ years

OCCUPATIONAL HISTORY

Have you ever worked in:

44. A foundry? (As long as one year) 1 ☐ Yes 2 ☐ No

45. Stone or mineral mining, quarrying or processing? (As long as one year) 1 ☐ Yes 2 ☐ No

46. Asbestos milling or processing? (Ever) 1 ☐ Yes 2 ☐ No

47. Cotton or cotton blend mill? (For controls only) 1 ☐ Yes 2 ☐ No

48. Other dusts, fumes or smoke? If yes, specify. 1 ☐ Yes 2 ☐ No

Type of exposure _____

Length of exposure _____

# APPENDIX B-III

# ABBREVIATED RESPIRATORY QUESTIONNAIRE

## A. IDENTIFICATION DATA

PLANT _____ SOCIAL SECURITY NO. _____
DAY MONTH (figures) YEAR (last 2 digits)

NAME _____ DATE OF INTERVIEW _____
(Surname)

_____ DATE OF BIRTH _____
(First Names) M F

ADDRESS _____ AGE _____ (8,9) SEX _____ (10)

_____ RACE | W | N | IND. | OTHER | (11)

INTERVIEWER: 1 2 3 4 5 6 7 8 (12)

WORK SHIFT: 1st _____ 2nd _____ 3rd _____ (13) STANDING HEIGHT _____ (14,15)

PRESENT WORK AREA WEIGHT _____ (16,18)

If working in more than one specified work area, X area where most of the work shift is spent. If "other," but spending 25% of the work shift in one of the specified work areas, classify in that work area. If carding department employee, check area within that department where most of the work shift is spent (if in doubt, check "throughout"). For work areas such as spinning and weaving where many work rooms may be involved, be sure to check the specific work room to which the employee is assigned — if he works in more than one work room within a department classify as 7 (all) for that department.

| | Workroom Number | (19) Open | (20) Pick | Area | (21) Card #1 | (22) #2 | (23) Spin | (24) Wind | (25) Twist | (26) Spool | (27) Warp | (28) Slash | (29) Weave | (30) Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT RISK (cotton & cotton blend) | 1 | | | Cards | | | | | | | | | | |
| | 2 | | | Draw | | | | | | | | | | |
| | 3 | | | Comb | | | | | | | | | | |
| | 4 | | | Rove | | | | | | | | | | |
| | 5 | | | Thru Out | | | | | | | | | | |
| | 6 | | | | | | | | | | | | | |
| | 7 (all) | | | | | | | | | | | | | |
| Control (synthetic & wool) | 8 | | | | | | | | | | | | | |
| Ex-Worker (cotton) | 9 | | | | | | | | | | | | | |

Use actual wording of each question. Put X in appropriate square after each question. When in doubt record 'No'. When no square, circle appropriate answer.

B. COUGH

Do you usually cough first thing in the morning? (on getting up)† _____ Yes ___ No ___ (31)
(Count a cough with first smoke or on "first going out of doors." Exclude clearing throat or a single cough.)

Do you usually cough during the day or at night? _____ Yes ___ No ___ (32)
(Ignore an occasional cough.)

If 'Yes' to either question (31-32):

Do you cough like this on most days for as much as three months a year? _____ Yes ___ No ___ (33)

Do you cough on any particular day of the week? Yes ___ No ___ (34)

(1) (2) (3) (4) (5) (6) (7)

If 'Yes': Which day? Mon. Tues. Wed. Thur. Fri. Sat Sun. (35)

C. PHLEGM or alternative word to suit local custom.

Do you usually bring up any phlegm from your chest first thing in the morning? (Count phlegm with the first smoke or on "first going out of doors." Exclude phlegm from the nose. Count swallowed phlegm.) (on getting up)† _____ Yes ___ No ___ (36)

Do you usually bring up any phlegm from your chest during the day or at night? (Accept twice or more.) _____ Yes ___ No ___ (37)

If 'Yes' to either question (36) or (37):

Do you bring up phlegm like this on most days for as much as three months each year? _____ Yes ___ No ___ (38)

If 'Yes' to question (33) or (38):

How long have you had this phlegm? (cough)
(Write in number of years

(1) ☐ 2 years or less
(2) ☐ More than 2 years-5 years
(3) ☐ 10-19 years
(4) ☐ 20+ years

†These words are for subjects who work at night

D. TIGHTNESS

Does your chest ever feel tight or your breathing become difficult? _____ Yes ___ No ___ (39)

Is your chest tight or your breathing difficult on any particular day of the week? (after a week or 10 days away from the mill) _____ Yes ___ No ___ (40)

If 'Yes': Which day? Mon. (1) Tues. (2) Wed. (3) Thur. (4) Fri. (5) Sat. (6) Sun. (7) (8)

(1) Sometimes (2) Always (41)

If 'Yes' Monday: At what time on Monday does your chest feel tight or your breathing difficult? 1 ☐ Before entering the mill 2 ☐ After entering the mill (42)

(Ask only if NO to Question (45)

In the past, has your chest ever been tight or your breathing difficult on any particular day of the week? _____ Yes ___ No ___ (43)

If 'Yes': Which day? Mon. (1) Tues. (2) Wed. (3) Thur. (4) Fri. (5) Sat. (6) Sun. (7) (8) (44)

(1) Sometimes (2) Always

E. TOBACCO SMOKING

*Have you changed your smoking habits since last interview? If yes, specify what changes.

## APPENDIX B-IV
## Cuestionario Medico

1. Nótese: ¿Muestra el sujeto señales de resfraído o síntomas de grave infección respiratoria? ☐ Sí ☐ No (1)

2. Caso núm. _____ (2-6)

A. DATOS DE IDENTIFICACION

3. Desmotadora: _____ (7-11)

4. Nombre: _____ (Apellido)

_____ (Nombre de pila)

5. Dirección: _____

_____ (Ciudad)

6. Entrevistador: 1 2 3 4 5 6 7 8 (12-13)

7. Turno de Trabajo: 1 ____ 2 ____ (14)

8. Sitio de Trabajo Actual: (15)
   a. Balancero
   b. Corralero
   c. Succionero
   d. Desmotador
   e. Ayudante de desmotador
   f. Comprimidor
   g. Desemillador
   h. Basurero
   i. Quitahilachas
   j. Embalador

9. Número de Seguro Social
   ___-___-___ (16-24)

10. Fecha de Entrevista:
    Mes Día Año
    ___/___/___ (25-30)

11. Hora: _____ de la mañana de la tarde

12. Fecha de Nacimiento:
    Mes Día Año
    ___/___/___

13. Edad: _____ (31-32)

14. Sexo: Varón___ Hembra ___ (33)

15. Raza: B___N___M___O___ (34)

16. Altura Medida: ____(Pulgadas) (35-37)

17. Peso Medido: _____(Libras) (38-40)

### SINTOMAS RESPIRATORIAS

EMPLÉENSE LAS PALABRAS EXACTAS DE CADA PREGUNTA. PÓNGASE UNA "X" EN LA CASILLA QUE SIGUE CADA PREGUNTA. EN CASO DE DUDA, PÓNGASE "NO". DONDE NO HAY CASILLA, PÓNGASE UN CÍRCULO ALREDEDOR DE LA RESPUESTA APROPIADA.

INTRODUCCIÓN: LE VOY A HACER UNAS PREGUNTAS, POR LA MAYOR PARTE ACERCA DE LOS PULMONES. QUIERO QUE CONTESTE CON "SÍ" O "NO" CUANDO SEA POSIBLE.

B. LA TOS

18. ¿Tose Ud. ordinariamente al levantarse por la mañana? ☐ Sí ☐ No (41)

19. ¿Tose Ud. ordinariamente de dia o de moche? ☐ Sí ☐ No (42)

20. Si se contesta "Sí" a la pregunta 18 o 19, pregúntese: ¿Ha tosido así la mayoría de los días por un periodo de 3 meses durante el año pasado? ☐ Sí ☐ No ☐ NR (43)

21. Si se contesta "Sí" a 20, pregúntese: ¿Cuántos años hace que tose de esta manera?

Menos de 2 años _____ Más de 2 años _____ NR __ (44-45)

C. LA FLEMA (u otra palabra de uso local):

22. ¿Se arranca Ud. flema del pecho ordinariamente al levantarse?
(Tenga en cuenta la flema arrancada al fumar o al salir de la casa por primera vez. No tenga en cuenta los mucos nasales. Tenga en cuenta la flema que se traga.)

☐ Sí ☐ No (46)

23. ¿Se arranca Ud. alguna flema del pecho ordinariamente de día o de noche?
(Nótense sólo 2 veces o más)

☐ Sí ☐ No (47)

24. Si se contesta "Sí" a la pregunta 22 o 23, pregúntese: ¿Se ha arrancado flemas la mayoría de los días por un periodo de 3 meses durante el año pasado?

☐ Sí ☐ No ☐ NR (48)

25. Si se contesta "Sí" a 24, pregúntese:
¿Cuántos años hace que se arranca flemas así? _____Años

Menos de 2 años | Mas de 2 años | NR
_____ | _____ | ___ (49-50)

D. ENFERMEDADES PULMONARIAS

26. ¿Durante los tres años pasados, ha pasado algún periodo de tos* (aumentada) y flemas que duró 3 semanas o más?

* Sujetos que ordinariamente se arrancan flemas

☐ No
☐ Sí, uno solo
☐ Sí, dos o más (51)

27. ¿Ha tenido Ud. durante los 3 años pasados alguna enfermedad del pecho que le haya impedido a trabajar o le haya obligado a permanecer en casa, en cama por tanto como una semana? (Por ejemplo: ¿la gripe?)

☐ Sí ☐ No (52)

28. Si se contesta "Sí" a 27, pregúntese:
¿se arrancó Ud. más flemas que lo general durante alguno de estos ataques?

☐ Sí ☐ No ☐ NR (53)

29. Si se contesta "Sí" a 28, pregúntese:
¿Ha tenido durante los tres anos pasados:

Sólo un tal ataque con aumento de flemas? _____
Más de uno? _____
No cabe _____ (54)

30. Br. Grade
0_____(0)
1_____(1)
2_____(2)
3_____(3) (55)

31. ¿Resuella ruidosamente o tiene silbidos alguna vez en el pecho?

☐ Sí ☐ No (56)

32. Si se contesta "Sí" a 31, pregúntese:
¿Cuántas veces por año pasa eso? _____Veces

Menos de 50 | Más de 50 | NR
_____ | _____ | ___ (57-58)

E. LA DISPNEA (desaliento)

33. Sufre Ud. ataques de desaliento que no se relacionan con ningún esfuerzo físico? ☐ Sí ☐ No (59)

34. Si se contesta "Sí" a 33, pregúntese: Cuántos de tales ataques ha sufrido durante el año pasado? _____Ataques — Menos de 50 ____ Mas de 50 ____ NR ____ (60-61)

35. Si se inhabilita de caminar a causa de cualquier condicion que no sea enfermedad del corazón o del pecho, ponga una "X" y especifique: ____ _____ (62)

36. ¿Lo aflige un desaliento al caminar aprisa en terreno llano o al subir una pequeña cuesta? ☐ Sí ☐ No (63)

(Si "No," el grado es 1. Si es "Sí," siga a la pregunta siguiente.)

37. ¿Lo aflige un desaliento al caminar con otros de su propia edad a su paso ordinario en terreno llano? ☐ Sí ☐ No ☐ NR (64)

(Si "No," el grado es 2. Si es "Sí," prosiga)

38. ¿Tiene que detenerse porque se ahoga al caminar a paso ordinario en terreno llano? ☐ Sí ☐ No ☐ NR (65)

(Si "No," el grado es 3. Si es "Sí," prosiga)

39. ¿Se desalienta al lavarse o vestirse? ☐ Sí ☐ No ☐ NR (66)

(Si "No," el grado es 4. Si es "Sí," el grado es 5)

40. Dyspnea Grd._____ (67)

Introducción para las preguntas 40-43:

EL PRIMER DIA DE VUELTA AL TRABAJO DESPUES DE SUS DIAS LIBRES:

41. ¿Lo aflige un desaliento al caminar aprisa en terreno llano o al subir una pequeña cuesta? ☐ Sí ☐ No (68)

(Si "No," el grado es 1. Si es "Sí," siga a la pregunta siguiente.)

42. ¿Lo aflige un desaliento al caminar con otros de su propia edad a su paso ordinario en terreno llano? ☐ Sí ☐ No ☐ NR (69)

(Si "No," el grado es 2. Si es "Sí," prosiga)

43. ¿Tiene que detenerse porque se ahoga al caminar a paso ordinario en terreno llano? ☐ Sí ☐ No ☐ NR (70)

(Si "No," el grado es 3. Si es "Sí," prosiga)

44. ¿Se desalienta al lavarse o vestirse? ☐ Sí ☐ No ☐ NR (71)

(Si "No," el grado es 4. Si es "Sí," el grado es 5)

45. B. Grd. 0_____(0)
1/2_____(1)
1_____(2)
— 2_____(3)
— 3_____(4) (72)

46. ¿Ha tosido más que lo usual durante la semana pasada?

| Fecha | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sí | | | | | | | | | | | |
| No | | | | | | | | | | | |

(73)

47. ¿Se ha arrancado flemas del pecho o de día o de noche durante la semana pasada?

| Sí | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| No | | | | | | | | | | | |

(74)

48. ¿Ha tenido un "resfriado del pecho" durante la semana pasada?

| Fecha | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sí | | | | | | | | | | | |
| No | | | | | | | | | | | |

(75)

F. LA OPRESION EN EL PECHO

49. ¿Tiene Ud. alguna vez opresión en el pecho o dificultad de respirar?

| Sí | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| No | | | | | | | | | | | |

(76)

50. ¿Se le oprime el pecho o se le hace difícil respirar algún día de la semana en particular?

| Sí | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| No | | | | | | | | | | | |

(77)

51. Si se contesta "Sí" a 50, pregúntese: ¿Cuál día?

| D | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| L | | | | | | | | | | | |
| Mar. | | | | | | | | | | | |
| Mier. | | | | | | | | | | | |
| J | | | | | | | | | | | |
| V | | | | | | | | | | | |
| S | | | | | | | | | | | |
| Siempre | | | | | | | | | | | |
| A veces | | | | | | | | | | | |
| NR | | | | | | | | | | | |

(78-85)

52. ¿Se le oprime el pecho o se le hace difícil respirar:

a. ¿El primer día de vuelta al trabajo después de un día libre o más?

b. ¿El segundo día de vuelta al trabajo después de un día libre o más?

c. ¿El último día de trabajo antes de un día libre?

d. No cabe ninguna de las preguntas de arriba.

| Fecha | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

(86-89)

53. Si se contesta "Sí" a 52, pregúntese: ¿Siente opresión en el pecho o se le hace difícil respirar:

a. En todas tales ocasiones?
b. Sólo a veces.
c. No cabe.

Fecha | | | | | | | | | | | (90-92)

54. Si se contesta "Sí" a la pregunta 30 o 52, pregúntese: ¿A qué hora del día indicado siente opresión en el pecho o dificultad de respirar?

a. Antes de entrar en la desmotadora.
b. Después de entrar en la desmotadora.
c. Después de salir de la desmotadora.
d. No cabe.

Fecha | | | | | | | | | | | (93-96)

55. Si la respuesta a 54 "b" o "c" es afirmativa, pregúntese: ¿Cuántas horas después de empezar un turno comienza esto?

Horas_____
No cabe_____ (97-98)

56. Si la respuesta a 54 "b" o "c" es afirmativa, pregúntese: ¿Cuánto tiempo dura esta opresión o dificultad de respirar?

Horas_____
No cabe_____ (99-100)

57. (Pregúntese sólo si se contesta "No" a 50) En el pasado, ha sentido alguna vez opresión en el pecho o dificultad de respirar algún día de la semana en particular?

☐ Sí ☐ No ☐ NR (101)

58. Si se contesta "Sí" a 57, pregúntese: Cuál día?

D_____
L_____
Mar._____
Mier._____
J_____ Siempre___
V_____ A veces___
S_____ NR_____ (102)

59. (Pregúntese sólo si se contesta "No" a 52) ¿En el pasado, ha sentido alguna vez opresión en el pecho o dificultad de respirar?

a. El primer día de vuelta al trabajo después de un día libre o más. a._____

b. El segundo día de vuelta al trabajo después de un día libre o más. b._____

c. El último día de trabajo antes de un día libre. c._____ (103)

d. No cabe nada de lo de arriba. d._____

e. NR. e._____

60. Si se contesta "Sí" a 59, preguntese:
¿ Sentía Ud. opresión en el pecho o dificultad de respirar?

a. En toda (o casi toda) ocasion a____
b. Sólo a veces b____ (104)
c. No cabe c____

61. Si se contesta "Sí" a 50, 52, 57, O 59, pregúntese:
¿ Cuantos años hace que siente opresión en el pecho o dificultad de respirar? ____ Años☐ NR (105-106)

G. HISTORIA LABORAL

62. ¿ Qué clase de trabajo hace Ud. cuando no desmote el algodón (Especifique)? _____
_____ (107)
_____

Introducción para las preguntas 63 a 69: ¿ Ha trabajado Ud. alguna vez en:

63. Una fundición (por tanto como un año)? ☐ Sí ☐ No (108)

64. La minería o elaboración de piedra o metales (por tanto como un año)? ☐ Sí ☐ No (109)

65. En una planta de asbesto (alguna vez)? ☐ Sí ☐ No (110)

66. En una fábrica de textil de algodón, de mezclado de algondon o de aceite de semilla de algodón? ☐ Sí ☐ No (111)

67. En el cosecho de algodón o cereales? ☐ Sí ☐ No (112)

68. En una desmotadora de algodón (sólo para el grupo de control)? ☐ Sí ☐ No (113)

69. En proximidad de otros polvos, emanaciones o humos? Si se contesta "Sí," especifíquese: ☐ Sí ☐ No (114)
Clase de contacto_____
Duración de contacto_____

70. ¿ Cuántos años tenía cuando empezó a trabajar por primera vez en una desmotadora de algodón? (Escríbase su edad exacta)_____ (115-116)

71. ¿ Cuántos años hace que trabaja en una desmotadora de algodón? (Número total de años)_____ (117-118)

72. ¿ Cuántos meses por año trabaja ordinariamente en una desmotadora de algodón?_____ (Núm. de meses) (119-120)

73. ¿ En qué otras regiones del estado o del país ha trabajado (desmotando el algodón)?_____
_____ (121-122)
_____

H. OTRAS ENFERMEDADES

74. ¿Tiene Ud. una condición del corazón que requiere los servicios de un médico? ☐ Sí ☐ No (123)

75. Si se contesta "Sí" a 74, especifíquense la condición_____ .

la medicacion:_____

No cabe:_____

76. ¿Ha tenido alguna vez asma? ☐ Sí ☐ No (124)

77. Si se contesta "Si" a 76, pregúntese si empezó: ___Antes de los 30 anos
___Despues de los 30 anos
___NR

78. Si se contesta "Sí" a 76, pregúntese: Tenía asma antes de trabajar en una desmotadora de algodón? ☐ Sí ☐ No ☐ NR (125)

79. ¿Le ha dicho alguna vez un medico que Ud. Tenía alguna de las condiciones que siguen?

a. Bronquitis cronica ☐ Sí ☐ No (126)

b. Enfisema ☐ Sí ☐ No (127)

c. Infección fungoso de los pulmones ☐ Sí ☐ No (128)

d. Tisis (tuberculosis) ☐ Sí ☐ No (129)

e. Cualquier condición crónica de los pulmones ☐ Sí ☐ No (130)

Si se contesta "Sí," especifíquese:_____

_____

_____

I. CONSUMO DE TABACO

80. ¿Ha fumado Ud. alguna vez cigarrillos? ☐ Sí ☐ No (131)

(Si se contesta "Sí" a 80, pregúntese 81. Si "No," omítase lo que no quepa.)

81. ¿Fuma cigarrillos actualmente? ☐ Sí ☐ No ☐ NR (132)

(Si se contesta "Sí" a 81, pregúntese 82 a 84. Si "No," pregúntese 85 a 87.)

82. ¿Aproximadamente cuántos cigarrillos fuma ordinariamente por día? ____ Número ☐ NR (133-134)

83. ¿Inhala (aspira), digo, traga el humo? ☐ Sí ☐ No ☐ NR (135)

84. ¿Cuántos años hace que fuma cigarrillos? ____ Años ☐ NR (136-137)

(Omítase hasta 88)

85. ¿Cuando fumaba, cuántos cigarrillos consumía por día? ____ Número ☐ NR (138-139)

(Page 8)

86. ¿Inhalaba (aspiraba), digo, tragaba el humo? ☐ Sí ☐ No ☐ NR (140)

87. ¿Aproximadamente cuántos años hacía que fumaba cigarrillos? ____ Años ☐ NR (141-142)

88. ¿Ha fumado alguna vez puros? ☐ Sí ☐ No (143)

(Si se contesta "Sí" a 88, pregúntese 89 a 91. Si "No," omítase hasta 92.)

89. ¿Fuma puros actualmente? ☐ Sí ☐ No ☐ NR (144)

(Si se contesta "Sí" a 89, pregúntese 90 a 91. Si "No," omítase hasta 92.)

90. ¿Aprximadamente cuántos puros fuma ordinariamente por día? ____ Número ☐ NR (145-146)

91. ¿Aproximadamente cuántos años hace que fuma puros? ____ Años ☐ NR (147-148)

92. ¿Ha fumado alguna vez en pipa? ☐ Sí ☐ No (149)

(Si se contesta "Sí" a 92, pregúntese 93 a 95. Si "No," terminese la entrevista.)

93. Fuma en pipa actualmente? ☐ Sí ☐ No ☐ NR (150)

(Si se contesta "Sí" a 93, preguntese 94 a 95. Si "No," terminese la entrevista.)

94. ¿Aproximadamente cuántas pipadas de tabaco fuma ordinariamente por día? ____ Número ☐ NR (151-152)

95. ¿Aproximadamente cuántos años hace que fuma en pipa? ____ Años ☐ NR (153-154)

## APPENDIX C - SPIROMETRY PREDICTION TABLES FOR NORMAL MALES AND FEMALES

TABLE 1. PREDICTED FVC FOR MALES (HUDSON, ET AL. AM REV RESPIR DIS. 1976, 113, 587.)

| HT \ AGE | 17 | 19 | 21 | 23 | 25 | 27 | 29 | 31 | 33 | 35 | 37 | 39 | 41 | 43 | 45 | 47 | 49 | 51 | 53 | 55 | 57 | 59 | 61 | 63 | 65 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 60.0 | 3.44 | 3.59 | 3.75 | 3.91 | 3.72 | 3.66 | 3.61 | 3.55 | 3.49 | 3.43 | 3.37 | 3.32 | 3.26 | 3.20 | 3.14 | 3.08 | 3.03 | 2.97 | 2.91 | 2.85 | 2.79 | 2.74 | 2.68 | 2.62 | 2.56 |
| 60.5 | 3.50 | 3.66 | 3.81 | 3.97 | 3.80 | 3.75 | 3.69 | 3.63 | 3.57 | 3.51 | 3.46 | 3.40 | 3.34 | 3.28 | 3.22 | 3.17 | 3.11 | 3.05 | 2.99 | 2.93 | 2.88 | 2.82 | 2.76 | 2.70 | 2.64 |
| 61.0 | 3.56 | 3.72 | 3.88 | 4.03 | 3.89 | 3.83 | 3.77 | 3.71 | 3.66 | 3.60 | 3.54 | 3.48 | 3.42 | 3.37 | 3.31 | 3.25 | 3.19 | 3.13 | 3.08 | 3.02 | 2.96 | 2.90 | 2.84 | 2.79 | 2.73 |
| 61.5 | 3.63 | 3.78 | 3.94 | 4.10 | 3.97 | 3.91 | 3.85 | 3.80 | 3.74 | 3.68 | 3.62 | 3.56 | 3.51 | 3.45 | 3.39 | 3.33 | 3.27 | 3.22 | 3.16 | 3.10 | 3.04 | 2.98 | 2.93 | 2.87 | 2.81 |
| 62.0 | 3.69 | 3.85 | 4.00 | 4.16 | 4.05 | 3.99 | 3.94 | 3.88 | 3.82 | 3.76 | 3.70 | 3.65 | 3.59 | 3.53 | 3.47 | 3.41 | 3.36 | 3.30 | 3.24 | 3.18 | 3.12 | 3.07 | 3.01 | 2.95 | 2.89 |
| 62.5 | 3.76 | 3.91 | 4.07 | 4.22 | 4.13 | 4.08 | 4.02 | 3.96 | 3.90 | 3.84 | 3.79 | 3.73 | 3.67 | 3.61 | 3.55 | 3.50 | 3.44 | 3.38 | 3.32 | 3.26 | 3.21 | 3.15 | 3.09 | 3.03 | 2.97 |
| 63.0 | 3.82 | 3.97 | 4.13 | 4.29 | 4.22 | 4.16 | 4.10 | 4.04 | 3.99 | 3.93 | 3.87 | 3.81 | 3.75 | 3.70 | 3.64 | 3.58 | 3.52 | 3.46 | 3.41 | 3.35 | 3.29 | 3.23 | 3.17 | 3.12 | 3.06 |
| 63.5 | 3.88 | 4.04 | 4.19 | 4.35 | 4.30 | 4.24 | 4.18 | 4.13 | 4.07 | 4.01 | 3.95 | 3.89 | 3.84 | 3.78 | 3.72 | 3.66 | 3.60 | 3.55 | 3.49 | 3.43 | 3.37 | 3.31 | 3.26 | 3.20 | 3.14 |
| 64.0 | 3.95 | 4.10 | 4.26 | 4.41 | 4.38 | 4.32 | 4.27 | 4.21 | 4.15 | 4.09 | 4.03 | 3.98 | 3.92 | 3.86 | 3.80 | 3.74 | 3.69 | 3.63 | 3.57 | 3.51 | 3.45 | 3.40 | 3.34 | 3.28 | 3.22 |
| 64.5 | 4.01 | 4.17 | 4.32 | 4.48 | 4.46 | 4.41 | 4.35 | 4.29 | 4.23 | 4.17 | 4.12 | 4.06 | 4.00 | 3.94 | 3.88 | 3.83 | 3.77 | 3.71 | 3.65 | 3.59 | 3.54 | 3.48 | 3.42 | 3.36 | 3.30 |
| 65.0 | 4.07 | 4.23 | 4.39 | 4.54 | 4.55 | 4.49 | 4.43 | 4.37 | 4.32 | 4.26 | 4.20 | 4.14 | 4.08 | 4.03 | 3.97 | 3.91 | 3.85 | 3.79 | 3.74 | 3.68 | 3.62 | 3.56 | 3.50 | 3.45 | 3.39 |
| 65.5 | 4.14 | 4.29 | 4.45 | 4.60 | 4.63 | 4.57 | 4.51 | 4.46 | 4.40 | 4.34 | 4.28 | 4.22 | 4.17 | 4.11 | 4.05 | 3.99 | 3.93 | 3.88 | 3.82 | 3.76 | 3.70 | 3.64 | 3.59 | 3.53 | 3.47 |
| 66.0 | 4.20 | 4.36 | 4.51 | 4.67 | 4.71 | 4.65 | 4.60 | 4.54 | 4.48 | 4.42 | 4.36 | 4.31 | 4.25 | 4.19 | 4.13 | 4.07 | 4.02 | 3.96 | 3.90 | 3.84 | 3.78 | 3.73 | 3.67 | 3.61 | 3.55 |
| 66.5 | 4.26 | 4.42 | 4.58 | 4.73 | 4.80 | 4.74 | 4.68 | 4.62 | 4.56 | 4.51 | 4.45 | 4.39 | 4.33 | 4.27 | 4.22 | 4.16 | 4.10 | 4.04 | 3.98 | 3.93 | 3.87 | 3.81 | 3.75 | 3.69 | 3.64 |
| 67.0 | 4.33 | 4.48 | 4.64 | 4.80 | 4.88 | 4.82 | 4.76 | 4.70 | 4.65 | 4.59 | 4.53 | 4.47 | 4.41 | 4.36 | 4.30 | 4.24 | 4.18 | 4.12 | 4.07 | 4.01 | 3.95 | 3.89 | 3.83 | 3.78 | 3.72 |
| 67.5 | 4.39 | 4.55 | 4.70 | 4.86 | 4.96 | 4.90 | 4.84 | 4.79 | 4.73 | 4.67 | 4.61 | 4.55 | 4.50 | 4.44 | 4.38 | 4.32 | 4.26 | 4.21 | 4.15 | 4.09 | 4.03 | 3.97 | 3.92 | 3.86 | 3.80 |
| 68.0 | 4.45 | 4.61 | 4.77 | 4.92 | 5.04 | 4.98 | 4.93 | 4.87 | 4.81 | 4.75 | 4.69 | 4.64 | 4.58 | 4.52 | 4.46 | 4.40 | 4.35 | 4.29 | 4.23 | 4.17 | 4.11 | 4.06 | 4.00 | 3.94 | 3.88 |
| 68.5 | 4.52 | 4.67 | 4.83 | 4.99 | 5.13 | 5.07 | 5.01 | 4.95 | 4.89 | 4.84 | 4.78 | 4.72 | 4.66 | 4.60 | 4.55 | 4.49 | 4.43 | 4.37 | 4.31 | 4.26 | 4.20 | 4.14 | 4.08 | 4.02 | 3.97 |
| 69.0 | 4.58 | 4.74 | 4.89 | 5.05 | 5.21 | 5.15 | 5.09 | 5.03 | 4.98 | 4.92 | 4.86 | 4.80 | 4.74 | 4.69 | 4.63 | 4.57 | 4.51 | 4.45 | 4.40 | 4.34 | 4.28 | 4.22 | 4.16 | 4.11 | 4.05 |
| 69.5 | 4.64 | 4.80 | 4.96 | 5.11 | 5.29 | 5.23 | 5.17 | 5.12 | 5.06 | 5.00 | 4.94 | 4.88 | 4.83 | 4.77 | 4.71 | 4.65 | 4.59 | 4.54 | 4.48 | 4.42 | 4.36 | 4.30 | 4.25 | 4.19 | 4.13 |
| 70.0 | 4.71 | 4.86 | 5.02 | 5.18 | 5.37 | 5.32 | 5.26 | 5.20 | 5.14 | 5.08 | 5.02 | 4.97 | 4.91 | 4.85 | 4.79 | 4.74 | 4.68 | 4.62 | 4.56 | 4.50 | 4.44 | 4.39 | 4.33 | 4.27 | 4.21 |
| 70.5 | 4.77 | 4.93 | 5.08 | 5.24 | 5.46 | 5.40 | 5.34 | 5.28 | 5.22 | 5.17 | 5.11 | 5.05 | 4.99 | 4.93 | 4.88 | 4.82 | 4.76 | 4.70 | 4.64 | 4.59 | 4.53 | 4.47 | 4.41 | 4.35 | 4.30 |
| 71.0 | 4.83 | 4.99 | 5.15 | 5.30 | 5.54 | 5.48 | 5.42 | 5.36 | 5.31 | 5.25 | 5.19 | 5.13 | 5.07 | 5.02 | 4.96 | 4.90 | 4.84 | 4.78 | 4.73 | 4.67 | 4.61 | 4.55 | 4.49 | 4.44 | 4.38 |
| 71.5 | 4.90 | 5.05 | 5.21 | 5.37 | 5.62 | 5.56 | 5.50 | 5.45 | 5.39 | 5.33 | 5.27 | 5.21 | 5.16 | 5.10 | 5.04 | 4.98 | 4.92 | 4.87 | 4.81 | 4.75 | 4.69 | 4.63 | 4.58 | 4.52 | 4.46 |
| 72.0 | 4.96 | 5.12 | 5.27 | 5.43 | 5.70 | 5.65 | 5.59 | 5.53 | 5.47 | 5.41 | 5.36 | 5.30 | 5.24 | 5.18 | 5.12 | 5.07 | 5.01 | 4.95 | 4.89 | 4.83 | 4.78 | 4.72 | 4.66 | 4.60 | 4.54 |
| 72.5 | 5.03 | 5.18 | 5.34 | 5.49 | 5.79 | 5.73 | 5.67 | 5.61 | 5.55 | 5.50 | 5.44 | 5.38 | 5.32 | 5.26 | 5.21 | 5.15 | 5.09 | 5.03 | 4.97 | 4.92 | 4.86 | 4.80 | 4.74 | 4.68 | 4.63 |
| 73.0 | 5.09 | 5.24 | 5.40 | 5.56 | 5.87 | 5.81 | 5.75 | 5.69 | 5.64 | 5.58 | 5.52 | 5.46 | 5.40 | 5.35 | 5.29 | 5.23 | 5.17 | 5.11 | 5.06 | 5.00 | 4.94 | 4.88 | 4.82 | 4.77 | 4.71 |
| 73.5 | 5.15 | 5.31 | 5.46 | 5.62 | 5.95 | 5.89 | 5.83 | 5.78 | 5.72 | 5.66 | 5.60 | 5.54 | 5.49 | 5.43 | 5.37 | 5.31 | 5.25 | 5.20 | 5.14 | 5.08 | 5.02 | 4.96 | 4.91 | 4.85 | 4.79 |
| 74.0 | 5.22 | 5.37 | 5.53 | 5.68 | 6.03 | 5.98 | 5.92 | 5.86 | 5.80 | 5.74 | 5.69 | 5.63 | 5.57 | 5.51 | 5.45 | 5.40 | 5.34 | 5.28 | 5.22 | 5.16 | 5.11 | 5.05 | 4.99 | 4.93 | 4.87 |
| 74.5 | 5.28 | 5.44 | 5.59 | 5.75 | 6.12 | 6.06 | 6.00 | 5.94 | 5.88 | 5.83 | 5.77 | 5.71 | 5.65 | 5.59 | 5.54 | 5.48 | 5.42 | 5.36 | 5.30 | 5.25 | 5.19 | 5.13 | 5.07 | 5.01 | 4.96 |
| 75.0 | 5.34 | 5.50 | 5.65 | 5.81 | 6.20 | 6.14 | 6.08 | 6.02 | 5.97 | 5.91 | 5.85 | 5.79 | 5.73 | 5.68 | 5.62 | 5.56 | 5.50 | 5.44 | 5.39 | 5.33 | 5.27 | 5.21 | 5.15 | 5.10 | 5.04 |
| 75.5 | 5.41 | 5.56 | 5.72 | 5.87 | 6.28 | 6.22 | 6.17 | 6.11 | 6.05 | 5.99 | 5.93 | 5.88 | 5.82 | 5.76 | 5.70 | 5.64 | 5.59 | 5.53 | 5.47 | 5.41 | 5.35 | 5.30 | 5.24 | 5.18 | 5.12 |
| 76.0 | 5.47 | 5.63 | 5.78 | 5.94 | 6.36 | 6.31 | 6.25 | 6.19 | 6.13 | 6.07 | 6.02 | 5.96 | 5.90 | 5.84 | 5.78 | 5.73 | 5.67 | 5.61 | 5.55 | 5.49 | 5.44 | 5.38 | 5.32 | 5.26 | 5.20 |
| 76.5 | 5.53 | 5.69 | 5.85 | 6.00 | 6.45 | 6.39 | 6.33 | 6.27 | 6.21 | 6.16 | 6.10 | 6.04 | 5.98 | 5.92 | 5.87 | 5.81 | 5.75 | 5.69 | 5.63 | 5.58 | 5.52 | 5.46 | 5.40 | 5.34 | 5.29 |
| 77.0 | 5.60 | 5.75 | 5.91 | 6.06 | 6.53 | 6.47 | 6.41 | 6.35 | 6.30 | 6.24 | 6.18 | 6.12 | 6.06 | 6.01 | 5.95 | 5.89 | 5.83 | 5.77 | 5.72 | 5.66 | 5.60 | 5.54 | 5.48 | 5.43 | 5.37 |
| 77.5 | 5.66 | 5.82 | 5.97 | 6.13 | 6.61 | 6.55 | 6.50 | 6.44 | 6.38 | 6.32 | 6.26 | 6.21 | 6.15 | 6.09 | 6.03 | 5.97 | 5.92 | 5.86 | 5.80 | 5.74 | 5.68 | 5.63 | 5.57 | 5.51 | 5.45 |
| 78.0 | 5.72 | 5.88 | 6.04 | 6.19 | 6.69 | 6.64 | 6.58 | 6.52 | 6.46 | 6.40 | 6.35 | 6.29 | 6.23 | 6.17 | 6.11 | 6.06 | 6.00 | 5.94 | 5.88 | 5.82 | 5.77 | 5.71 | 5.65 | 5.59 | 5.53 |
| 78.5 | 5.79 | 5.94 | 6.10 | 6.26 | 6.78 | 6.72 | 6.66 | 6.60 | 6.54 | 6.49 | 6.43 | 6.37 | 6.31 | 6.25 | 6.20 | 6.14 | 6.08 | 6.02 | 5.96 | 5.91 | 5.85 | 5.79 | 5.73 | 5.67 | 5.62 |
| 79.0 | 5.85 | 6.01 | 6.16 | 6.32 | 6.86 | 6.80 | 6.74 | 6.68 | 6.63 | 6.57 | 6.51 | 6.45 | 6.39 | 6.34 | 6.28 | 6.22 | 6.16 | 6.10 | 6.05 | 5.99 | 5.93 | 5.87 | 5.81 | 5.76 | 5.70 |
| 79.5 | 5.91 | 6.07 | 6.23 | 6.38 | 6.94 | 6.88 | 6.83 | 6.77 | 6.71 | 6.65 | 6.59 | 6.54 | 6.48 | 6.42 | 6.36 | 6.30 | 6.25 | 6.19 | 6.13 | 6.07 | 6.01 | 5.96 | 5.90 | 5.84 | 5.78 |
| 80.0 | 5.98 | 6.13 | 6.29 | 6.45 | 7.02 | 6.97 | 6.91 | 6.85 | 6.79 | 6.73 | 6.68 | 6.62 | 6.56 | 6.50 | 6.44 | 6.39 | 6.33 | 6.27 | 6.21 | 6.15 | 6.10 | 6.04 | 5.98 | 5.92 | 5.86 |
| 80.5 | 6.04 | 6.20 | 6.35 | 6.51 | 7.11 | 7.05 | 6.99 | 6.93 | 6.87 | 6.82 | 6.76 | 6.70 | 6.64 | 6.58 | 6.53 | 6.47 | 6.41 | 6.35 | 6.29 | 6.24 | 6.18 | 6.12 | 6.06 | 6.00 | 5.95 |
| 81.0 | 6.10 | 6.26 | 6.42 | 6.57 | 7.19 | 7.13 | 7.07 | 7.02 | 6.96 | 6.90 | 6.84 | 6.78 | 6.73 | 6.67 | 6.61 | 6.55 | 6.49 | 6.44 | 6.38 | 6.32 | 6.26 | 6.20 | 6.15 | 6.09 | 6.03 |
| 81.5 | 6.17 | 6.32 | 6.48 | 6.64 | 7.27 | 7.21 | 7.16 | 7.10 | 7.04 | 6.98 | 6.92 | 6.87 | 6.81 | 6.75 | 6.69 | 6.63 | 6.58 | 6.52 | 6.46 | 6.40 | 6.34 | 6.29 | 6.23 | 6.17 | 6.11 |
| 82.0 | 6.23 | 6.39 | 6.54 | 6.70 | 7.35 | 7.30 | 7.24 | 7.18 | 7.12 | 7.06 | 7.01 | 6.95 | 6.89 | 6.83 | 6.77 | 6.72 | 6.66 | 6.60 | 6.54 | 6.48 | 6.43 | 6.37 | 6.31 | 6.25 | 6.19 |
| 82.5 | 6.30 | 6.45 | 6.61 | 6.76 | 7.44 | 7.38 | 7.32 | 7.26 | 7.20 | 7.15 | 7.09 | 7.03 | 6.97 | 6.91 | 6.86 | 6.80 | 6.74 | 6.68 | 6.62 | 6.57 | 6.51 | 6.45 | 6.39 | 6.33 | 6.28 |
| 83.0 | 6.36 | 6.51 | 6.67 | 6.83 | 7.52 | 7.46 | 7.40 | 7.35 | 7.29 | 7.23 | 7.17 | 7.11 | 7.06 | 7.00 | 6.94 | 6.88 | 6.82 | 6.77 | 6.71 | 6.65 | 6.59 | 6.53 | 6.48 | 6.42 | 6.36 |
| 83.5 | 6.42 | 6.58 | 6.73 | 6.89 | 7.60 | 7.54 | 7.49 | 7.43 | 7.37 | 7.31 | 7.25 | 7.20 | 7.14 | 7.08 | 7.02 | 6.96 | 6.91 | 6.85 | 6.79 | 6.73 | 6.67 | 6.62 | 6.56 | 6.50 | 6.44 |
| 84.0 | 6.49 | 6.64 | 6.80 | 6.95 | 7.68 | 7.63 | 7.57 | 7.51 | 7.45 | 7.39 | 7.34 | 7.28 | 7.22 | 7.16 | 7.10 | 7.05 | 6.99 | 6.93 | 6.87 | 6.81 | 6.76 | 6.70 | 6.64 | 6.58 | 6.52 |
| 84.5 | 6.55 | 6.71 | 6.86 | 7.02 | 7.77 | 7.71 | 7.65 | 7.59 | 7.53 | 7.48 | 7.42 | 7.36 | 7.30 | 7.24 | 7.19 | 7.13 | 7.07 | 7.01 | 6.95 | 6.90 | 6.84 | 6.78 | 6.72 | 6.66 | 6.61 |
| 85.0 | 6.61 | 6.77 | 6.92 | 7.08 | 7.85 | 7.79 | 7.73 | 7.68 | 7.62 | 7.56 | 7.50 | 7.44 | 7.39 | 7.33 | 7.27 | 7.21 | 7.15 | 7.10 | 7.04 | 6.98 | 6.92 | 6.86 | 6.81 | 6.75 | 6.69 |

TABLE 2. PREDICTED FEV1 FOR MALES (HUDSON, ET AL: AM REV RESPIR DIS. 1976, 113, 587.)

| HT | AGE 17 | 19 | 21 | 23 | 25 | 27 | 29 | 31 | 33 | 35 | 37 | 39 | 41 | 43 | 45 | 47 | 49 | 51 | 53 | 55 | 57 | 59 | 61 | 63 | 65 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 60.0 | 2.97 | 3.06 | 3.15 | 3.24 | 3.05 | 2.99 | 2.94 | 2.88 | 2.83 | 2.78 | 2.72 | 2.67 | 2.61 | 2.56 | 2.51 | 2.45 | 2.40 | 2.34 | 2.29 | 2.24 | 2.18 | 2.13 | 2.07 | 2.02 | 1.97 |
| 60.5 | 3.03 | 3.12 | 3.21 | 3.30 | 3.11 | 3.06 | 3.00 | 2.95 | 2.90 | 2.84 | 2.79 | 2.73 | 2.68 | 2.63 | 2.57 | 2.52 | 2.46 | 2.41 | 2.36 | 2.30 | 2.25 | 2.19 | 2.14 | 2.09 | 2.03 |
| 61.0 | 3.08 | 3.17 | 3.26 | 3.35 | 3.18 | 3.12 | 3.07 | 3.02 | 2.96 | 2.91 | 2.85 | 2.80 | 2.75 | 2.69 | 2.64 | 2.58 | 2.53 | 2.48 | 2.42 | 2.37 | 2.31 | 2.26 | 2.21 | 2.15 | 2.10 |
| 61.5 | 3.14 | 3.23 | 3.32 | 3.41 | 3.24 | 3.19 | 3.14 | 3.08 | 3.03 | 2.97 | 2.92 | 2.87 | 2.81 | 2.76 | 2.70 | 2.65 | 2.60 | 2.54 | 2.49 | 2.43 | 2.38 | 2.33 | 2.27 | 2.22 | 2.16 |
| 62.0 | 3.20 | 3.29 | 3.38 | 3.47 | 3.31 | 3.26 | 3.20 | 3.15 | 3.09 | 3.04 | 2.99 | 2.93 | 2.88 | 2.82 | 2.77 | 2.72 | 2.66 | 2.61 | 2.55 | 2.50 | 2.45 | 2.39 | 2.34 | 2.28 | 2.23 |
| 62.5 | 3.26 | 3.35 | 3.44 | 3.53 | 3.38 | 3.32 | 3.27 | 3.22 | 3.16 | 3.11 | 3.05 | 3.00 | 2.95 | 2.89 | 2.84 | 2.78 | 2.73 | 2.68 | 2.62 | 2.57 | 2.51 | 2.46 | 2.41 | 2.35 | 2.30 |
| 63.0 | 3.32 | 3.41 | 3.50 | 3.59 | 3.44 | 3.39 | 3.34 | 3.28 | 3.23 | 3.17 | 3.12 | 3.07 | 3.01 | 2.96 | 2.90 | 2.85 | 2.80 | 2.74 | 2.69 | 2.63 | 2.58 | 2.53 | 2.47 | 2.42 | 2.36 |
| 63.5 | 3.38 | 3.47 | 3.56 | 3.65 | 3.51 | 3.46 | 3.40 | 3.35 | 3.29 | 3.24 | 3.19 | 3.13 | 3.08 | 3.02 | 2.97 | 2.92 | 2.86 | 2.81 | 2.75 | 2.70 | 2.65 | 2.59 | 2.54 | 2.48 | 2.43 |
| 64.0 | 3.43 | 3.52 | 3.61 | 3.70 | 3.58 | 3.52 | 3.47 | 3.41 | 3.36 | 3.31 | 3.25 | 3.20 | 3.14 | 3.09 | 3.04 | 2.98 | 2.93 | 2.87 | 2.82 | 2.77 | 2.71 | 2.66 | 2.60 | 2.55 | 2.50 |
| 64.5 | 3.49 | 3.58 | 3.67 | 3.76 | 3.64 | 3.59 | 3.53 | 3.48 | 3.43 | 3.37 | 3.32 | 3.26 | 3.21 | 3.16 | 3.10 | 3.05 | 2.99 | 2.94 | 2.89 | 2.83 | 2.78 | 2.72 | 2.67 | 2.62 | 2.56 |
| 65.0 | 3.55 | 3.64 | 3.73 | 3.82 | 3.71 | 3.65 | 3.60 | 3.55 | 3.49 | 3.44 | 3.38 | 3.33 | 3.28 | 3.22 | 3.17 | 3.11 | 3.06 | 3.01 | 2.95 | 2.90 | 2.84 | 2.79 | 2.74 | 2.68 | 2.63 |
| 65.5 | 3.61 | 3.70 | 3.79 | 3.88 | 3.77 | 3.72 | 3.67 | 3.61 | 3.56 | 3.50 | 3.45 | 3.40 | 3.34 | 3.29 | 3.23 | 3.18 | 3.13 | 3.07 | 3.02 | 2.96 | 2.91 | 2.86 | 2.80 | 2.75 | 2.69 |
| 66.0 | 3.67 | 3.76 | 3.85 | 3.94 | 3.84 | 3.79 | 3.73 | 3.68 | 3.62 | 3.57 | 3.52 | 3.46 | 3.41 | 3.35 | 3.30 | 3.25 | 3.19 | 3.14 | 3.08 | 3.03 | 2.98 | 2.92 | 2.87 | 2.81 | 2.76 |
| 66.5 | 3.73 | 3.82 | 3.91 | 4.00 | 3.91 | 3.85 | 3.80 | 3.74 | 3.69 | 3.64 | 3.58 | 3.53 | 3.47 | 3.42 | 3.37 | 3.31 | 3.26 | 3.20 | 3.15 | 3.10 | 3.04 | 2.99 | 2.93 | 2.88 | 2.83 |
| 67.0 | 3.79 | 3.88 | 3.97 | 4.06 | 3.97 | 3.92 | 3.86 | 3.81 | 3.76 | 3.70 | 3.65 | 3.59 | 3.54 | 3.49 | 3.43 | 3.38 | 3.32 | 3.27 | 3.22 | 3.16 | 3.11 | 3.05 | 3.00 | 2.95 | 2.89 |
| 67.5 | 3.84 | 3.93 | 4.02 | 4.11 | 4.04 | 3.98 | 3.93 | 3.88 | 3.82 | 3.77 | 3.71 | 3.66 | 3.61 | 3.55 | 3.50 | 3.44 | 3.39 | 3.34 | 3.28 | 3.23 | 3.17 | 3.12 | 3.07 | 3.01 | 2.96 |
| 68.0 | 3.90 | 3.99 | 4.08 | 4.17 | 4.10 | 4.05 | 4.00 | 3.94 | 3.89 | 3.83 | 3.78 | 3.73 | 3.67 | 3.62 | 3.56 | 3.51 | 3.46 | 3.40 | 3.35 | 3.29 | 3.24 | 3.19 | 3.13 | 3.08 | 3.02 |
| 68.5 | 3.96 | 4.05 | 4.14 | 4.23 | 4.17 | 4.12 | 4.06 | 4.01 | 3.95 | 3.90 | 3.85 | 3.79 | 3.74 | 3.68 | 3.63 | 3.58 | 3.52 | 3.47 | 3.41 | 3.36 | 3.31 | 3.25 | 3.20 | 3.14 | 3.09 |
| 69.0 | 4.02 | 4.11 | 4.20 | 4.29 | 4.24 | 4.18 | 4.13 | 4.07 | 4.02 | 3.97 | 3.91 | 3.86 | 3.80 | 3.75 | 3.70 | 3.64 | 3.59 | 3.53 | 3.48 | 3.43 | 3.37 | 3.32 | 3.26 | 3.21 | 3.16 |
| 69.5 | 4.08 | 4.17 | 4.26 | 4.35 | 4.30 | 4.25 | 4.19 | 4.14 | 4.09 | 4.03 | 3.98 | 3.92 | 3.87 | 3.82 | 3.76 | 3.71 | 3.65 | 3.60 | 3.55 | 3.49 | 3.44 | 3.38 | 3.33 | 3.28 | 3.22 |
| 70.0 | 4.14 | 4.23 | 4.32 | 4.41 | 4.37 | 4.31 | 4.26 | 4.21 | 4.15 | 4.10 | 4.04 | 3.99 | 3.94 | 3.88 | 3.83 | 3.77 | 3.72 | 3.67 | 3.61 | 3.56 | 3.50 | 3.45 | 3.40 | 3.34 | 3.29 |
| 70.5 | 4.19 | 4.28 | 4.37 | 4.46 | 4.43 | 4.38 | 4.33 | 4.27 | 4.22 | 4.16 | 4.11 | 4.06 | 4.00 | 3.95 | 3.89 | 3.84 | 3.79 | 3.73 | 3.68 | 3.62 | 3.57 | 3.52 | 3.46 | 3.41 | 3.35 |
| 71.0 | 4.25 | 4.34 | 4.43 | 4.52 | 4.50 | 4.45 | 4.39 | 4.34 | 4.28 | 4.23 | 4.18 | 4.12 | 4.07 | 4.01 | 3.96 | 3.91 | 3.85 | 3.80 | 3.74 | 3.69 | 3.64 | 3.58 | 3.53 | 3.47 | 3.42 |
| 71.5 | 4.31 | 4.40 | 4.49 | 4.58 | 4.57 | 4.51 | 4.46 | 4.40 | 4.35 | 4.30 | 4.24 | 4.19 | 4.13 | 4.08 | 4.03 | 3.97 | 3.92 | 3.86 | 3.81 | 3.76 | 3.70 | 3.65 | 3.59 | 3.54 | 3.49 |
| 72.0 | 4.37 | 4.46 | 4.55 | 4.64 | 4.63 | 4.58 | 4.52 | 4.47 | 4.42 | 4.36 | 4.31 | 4.25 | 4.20 | 4.15 | 4.09 | 4.04 | 3.98 | 3.93 | 3.88 | 3.82 | 3.77 | 3.71 | 3.66 | 3.61 | 3.55 |
| 72.5 | 4.43 | 4.52 | 4.61 | 4.70 | 4.70 | 4.64 | 4.59 | 4.54 | 4.48 | 4.43 | 4.37 | 4.32 | 4.27 | 4.21 | 4.16 | 4.10 | 4.05 | 4.00 | 3.94 | 3.89 | 3.83 | 3.78 | 3.73 | 3.67 | 3.62 |
| 73.0 | 4.49 | 4.58 | 4.67 | 4.76 | 4.76 | 4.71 | 4.66 | 4.60 | 4.55 | 4.49 | 4.44 | 4.39 | 4.33 | 4.28 | 4.22 | 4.17 | 4.12 | 4.06 | 4.01 | 3.95 | 3.90 | 3.85 | 3.79 | 3.74 | 3.68 |
| 73.5 | 4.54 | 4.63 | 4.72 | 4.81 | 4.83 | 4.78 | 4.72 | 4.67 | 4.61 | 4.56 | 4.51 | 4.45 | 4.40 | 4.34 | 4.29 | 4.24 | 4.18 | 4.13 | 4.07 | 4.02 | 3.97 | 3.91 | 3.86 | 3.80 | 3.75 |
| 74.0 | 4.60 | 4.69 | 4.78 | 4.87 | 4.90 | 4.84 | 4.79 | 4.73 | 4.68 | 4.63 | 4.57 | 4.52 | 4.46 | 4.41 | 4.36 | 4.30 | 4.25 | 4.19 | 4.14 | 4.09 | 4.03 | 3.98 | 3.92 | 3.87 | 3.82 |
| 74.5 | 4.66 | 4.75 | 4.84 | 4.93 | 4.96 | 4.91 | 4.85 | 4.80 | 4.75 | 4.69 | 4.64 | 4.58 | 4.53 | 4.48 | 4.42 | 4.37 | 4.31 | 4.26 | 4.21 | 4.15 | 4.10 | 4.04 | 3.99 | 3.94 | 3.88 |
| 75.0 | 4.72 | 4.81 | 4.90 | 4.99 | 5.03 | 4.97 | 4.92 | 4.87 | 4.81 | 4.76 | 4.70 | 4.65 | 4.60 | 4.54 | 4.49 | 4.43 | 4.38 | 4.33 | 4.27 | 4.22 | 4.16 | 4.11 | 4.06 | 4.00 | 3.95 |
| 75.5 | 4.78 | 4.87 | 4.96 | 5.05 | 5.09 | 5.04 | 4.99 | 4.93 | 4.88 | 4.82 | 4.77 | 4.72 | 4.66 | 4.61 | 4.55 | 4.50 | 4.45 | 4.39 | 4.34 | 4.28 | 4.23 | 4.18 | 4.12 | 4.07 | 4.01 |
| 76.0 | 4.84 | 4.93 | 5.02 | 5.11 | 5.16 | 5.11 | 5.05 | 5.00 | 4.94 | 4.89 | 4.84 | 4.78 | 4.73 | 4.67 | 4.62 | 4.57 | 4.51 | 4.46 | 4.40 | 4.35 | 4.30 | 4.24 | 4.19 | 4.13 | 4.08 |
| 76.5 | 4.90 | 4.99 | 5.08 | 5.17 | 5.23 | 5.17 | 5.12 | 5.06 | 5.01 | 4.96 | 4.90 | 4.85 | 4.79 | 4.74 | 4.69 | 4.63 | 4.58 | 4.52 | 4.47 | 4.42 | 4.36 | 4.31 | 4.25 | 4.20 | 4.15 |
| 77.0 | 4.95 | 5.04 | 5.13 | 5.22 | 5.29 | 5.24 | 5.18 | 5.13 | 5.08 | 5.02 | 4.97 | 4.91 | 4.86 | 4.81 | 4.75 | 4.70 | 4.64 | 4.59 | 4.54 | 4.48 | 4.43 | 4.37 | 4.32 | 4.27 | 4.21 |
| 77.5 | 5.01 | 5.10 | 5.19 | 5.28 | 5.36 | 5.30 | 5.25 | 5.20 | 5.14 | 5.09 | 5.03 | 4.98 | 4.93 | 4.87 | 4.82 | 4.76 | 4.71 | 4.66 | 4.60 | 4.55 | 4.49 | 4.44 | 4.39 | 4.33 | 4.28 |
| 78.0 | 5.07 | 5.16 | 5.25 | 5.34 | 5.42 | 5.37 | 5.32 | 5.26 | 5.21 | 5.15 | 5.10 | 5.05 | 4.99 | 4.94 | 4.88 | 4.83 | 4.78 | 4.72 | 4.67 | 4.61 | 4.56 | 4.51 | 4.45 | 4.40 | 4.34 |
| 78.5 | 5.13 | 5.22 | 5.31 | 5.40 | 5.49 | 5.44 | 5.38 | 5.33 | 5.27 | 5.22 | 5.17 | 5.11 | 5.06 | 5.00 | 4.95 | 4.90 | 4.84 | 4.79 | 4.73 | 4.68 | 4.63 | 4.57 | 4.52 | 4.46 | 4.41 |
| 79.0 | 5.19 | 5.28 | 5.37 | 5.46 | 5.56 | 5.50 | 5.45 | 5.39 | 5.34 | 5.29 | 5.23 | 5.18 | 5.12 | 5.07 | 5.02 | 4.96 | 4.91 | 4.85 | 4.80 | 4.75 | 4.69 | 4.64 | 4.58 | 4.53 | 4.48 |
| 79.5 | 5.25 | 5.34 | 5.43 | 5.52 | 5.62 | 5.57 | 5.51 | 5.46 | 5.41 | 5.35 | 5.30 | 5.24 | 5.19 | 5.14 | 5.08 | 5.03 | 4.97 | 4.92 | 4.87 | 4.81 | 4.76 | 4.70 | 4.65 | 4.60 | 4.54 |
| 80.0 | 5.30 | 5.39 | 5.48 | 5.57 | 5.69 | 5.63 | 5.58 | 5.53 | 5.47 | 5.42 | 5.36 | 5.31 | 5.26 | 5.20 | 5.15 | 5.09 | 5.04 | 4.99 | 4.93 | 4.88 | 4.82 | 4.77 | 4.72 | 4.66 | 4.61 |
| 80.5 | 5.36 | 5.45 | 5.54 | 5.63 | 5.75 | 5.70 | 5.65 | 5.59 | 5.54 | 5.48 | 5.43 | 5.38 | 5.32 | 5.27 | 5.21 | 5.16 | 5.11 | 5.05 | 5.00 | 4.94 | 4.89 | 4.84 | 4.78 | 4.73 | 4.67 |
| 81.0 | 5.42 | 5.51 | 5.60 | 5.69 | 5.82 | 5.77 | 5.71 | 5.66 | 5.60 | 5.55 | 5.50 | 5.44 | 5.39 | 5.33 | 5.28 | 5.23 | 5.17 | 5.12 | 5.06 | 5.01 | 4.96 | 4.90 | 4.85 | 4.79 | 4.74 |
| 81.5 | 5.48 | 5.57 | 5.66 | 5.75 | 5.89 | 5.83 | 5.78 | 5.72 | 5.67 | 5.62 | 5.56 | 5.51 | 5.45 | 5.40 | 5.35 | 5.29 | 5.24 | 5.18 | 5.13 | 5.08 | 5.02 | 4.97 | 4.91 | 4.86 | 4.81 |
| 82.0 | 5.54 | 5.63 | 5.72 | 5.81 | 5.95 | 5.90 | 5.84 | 5.79 | 5.74 | 5.68 | 5.63 | 5.57 | 5.52 | 5.47 | 5.41 | 5.36 | 5.30 | 5.25 | 5.20 | 5.14 | 5.09 | 5.03 | 4.98 | 4.93 | 4.87 |
| 82.5 | 5.60 | 5.69 | 5.78 | 5.87 | 6.02 | 5.96 | 5.91 | 5.86 | 5.80 | 5.75 | 5.69 | 5.64 | 5.59 | 5.53 | 5.48 | 5.42 | 5.37 | 5.32 | 5.26 | 5.21 | 5.15 | 5.10 | 5.05 | 4.99 | 4.94 |
| 83.0 | 5.65 | 5.74 | 5.83 | 5.92 | 6.08 | 6.03 | 5.98 | 5.92 | 5.87 | 5.81 | 5.76 | 5.71 | 5.65 | 5.60 | 5.54 | 5.49 | 5.44 | 5.38 | 5.33 | 5.27 | 5.22 | 5.17 | 5.11 | 5.06 | 5.00 |
| 83.5 | 5.71 | 5.80 | 5.89 | 5.98 | 6.15 | 6.10 | 6.04 | 5.99 | 5.93 | 5.86 | 5.03 | 5.77 | 5.72 | 5.66 | 5.61 | 5.56 | 5.50 | 5.45 | 5.39 | 5.34 | 5.29 | 5.23 | 5.18 | 5.12 | 5.07 |
| 84.0 | 5.77 | 5.86 | 5.95 | 6.04 | 6.22 | 6.16 | 6.11 | 6.05 | 6.00 | 5.95 | 5.89 | 5.84 | 5.78 | 5.73 | 5.68 | 5.62 | 5.57 | 5.51 | 5.46 | 5.41 | 5.35 | 5.30 | 5.24 | 5.19 | 5.14 |
| 84.5 | 5.83 | 5.92 | 6.01 | 6.10 | 6.28 | 6.23 | 6.17 | 6.12 | 6.07 | 6.01 | 5.96 | 5.90 | 5.85 | 5.80 | 5.74 | 5.69 | 5.63 | 5.58 | 5.53 | 5.47 | 5.42 | 5.36 | 5.31 | 5.26 | 5.20 |
| 85.0 | 5.89 | 5.98 | 6.07 | 6.16 | 6.35 | 6.29 | 6.24 | 6.19 | 6.13 | 6.08 | 6.02 | 5.97 | 5.92 | 5.86 | 5.81 | 5.75 | 5.70 | 5.65 | 5.59 | 5.54 | 5.48 | 5.43 | 5.38 | 5.32 | 5.27 |

TABLE 3. PREDICTED FVC FOR FEMALES (HUDSON, ET AL.: AM REV RESPIR DIS. 1976, 113, 587.)

| HT | AGE 17 | 19 | 21 | 23 | 25 | 27 | 29 | 31 | 33 | 35 | 37 | 39 | 41 | 43 | 45 | 47 | 49 | 51 | 53 | 55 | 57 | 59 | 61 | 63 | 65 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 52.0 | 2.45 | 2.64 | 2.65 | 2.61 | 2.56 | 2.52 | 2.47 | 2.43 | 2.39 | 2.34 | 2.30 | 2.25 | 2.21 | 2.17 | 2.12 | 2.08 | 2.03 | 1.99 | 1.95 | 1.90 | 1.86 | 1.81 | 1.77 | 1.73 | 1.68 |
| 52.5 | 2.50 | 2.68 | 2.70 | 2.65 | 2.61 | 2.57 | 2.52 | 2.48 | 2.43 | 2.39 | 2.35 | 2.30 | 2.26 | 2.21 | 2.17 | 2.13 | 2.08 | 2.04 | 1.99 | 1.95 | 1.91 | 1.86 | 1.82 | 1.77 | 1.73 |
| 53.0 | 2.54 | 2.72 | 2.74 | 2.70 | 2.66 | 2.61 | 2.57 | 2.52 | 2.48 | 2.44 | 2.39 | 2.35 | 2.30 | 2.26 | 2.22 | 2.17 | 2.13 | 2.08 | 2.04 | 2.00 | 1.95 | 1.91 | 1.86 | 1.82 | 1.78 |
| 53.5 | 2.58 | 2.76 | 2.79 | 2.75 | 2.70 | 2.66 | 2.62 | 2.57 | 2.53 | 2.48 | 2.44 | 2.40 | 2.35 | 2.31 | 2.26 | 2.22 | 2.18 | 2.13 | 2.09 | 2.04 | 2.00 | 1.96 | 1.91 | 1.87 | 1.82 |
| 54.0 | 2.62 | 2.81 | 2.84 | 2.79 | 2.75 | 2.71 | 2.66 | 2.62 | 2.57 | 2.53 | 2.49 | 2.44 | 2.40 | 2.35 | 2.31 | 2.27 | 2.22 | 2.18 | 2.13 | 2.09 | 2.05 | 2.00 | 1.96 | 1.91 | 1.87 |
| 54.5 | 2.66 | 2.85 | 2.89 | 2.84 | 2.80 | 2.75 | 2.71 | 2.67 | 2.62 | 2.58 | 2.53 | 2.49 | 2.45 | 2.40 | 2.36 | 2.31 | 2.27 | 2.23 | 2.18 | 2.14 | 2.09 | 2.05 | 2.01 | 1.96 | 1.92 |
| 55.0 | 2.71 | 2.89 | 2.93 | 2.89 | 2.84 | 2.80 | 2.76 | 2.71 | 2.67 | 2.62 | 2.58 | 2.54 | 2.49 | 2.45 | 2.40 | 2.36 | 2.32 | 2.27 | 2.23 | 2.18 | 2.14 | 2.10 | 2.05 | 2.01 | 1.96 |
| 55.5 | 2.75 | 2.93 | 2.98 | 2.94 | 2.89 | 2.85 | 2.80 | 2.76 | 2.72 | 2.67 | 2.63 | 2.58 | 2.54 | 2.50 | 2.45 | 2.41 | 2.36 | 2.32 | 2.28 | 2.23 | 2.19 | 2.14 | 2.10 | 2.06 | 2.01 |
| 56.0 | 2.79 | 2.97 | 3.03 | 2.98 | 2.94 | 2.89 | 2.85 | 2.81 | 2.76 | 2.72 | 2.67 | 2.63 | 2.59 | 2.54 | 2.50 | 2.45 | 2.41 | 2.37 | 2.32 | 2.28 | 2.23 | 2.19 | 2.15 | 2.10 | 2.06 |
| 56.5 | 2.83 | 3.01 | 3.07 | 3.03 | 2.99 | 2.94 | 2.90 | 2.85 | 2.81 | 2.77 | 2.72 | 2.68 | 2.63 | 2.59 | 2.55 | 2.50 | 2.46 | 2.41 | 2.37 | 2.33 | 2.28 | 2.24 | 2.19 | 2.15 | 2.11 |
| 57.0 | 2.87 | 3.06 | 3.12 | 3.08 | 3.03 | 2.99 | 2.94 | 2.90 | 2.86 | 2.81 | 2.77 | 2.72 | 2.68 | 2.64 | 2.59 | 2.55 | 2.50 | 2.46 | 2.42 | 2.37 | 2.33 | 2.28 | 2.24 | 2.20 | 2.15 |
| 57.5 | 2.91 | 3.10 | 3.17 | 3.12 | 3.08 | 3.04 | 2.99 | 2.95 | 2.90 | 2.86 | 2.82 | 2.77 | 2.73 | 2.68 | 2.64 | 2.60 | 2.55 | 2.51 | 2.46 | 2.42 | 2.38 | 2.33 | 2.29 | 2.24 | 2.20 |
| 58.0 | 2.96 | 3.14 | 3.21 | 3.17 | 3.13 | 3.08 | 3.04 | 2.99 | 2.95 | 2.91 | 2.86 | 2.82 | 2.77 | 2.73 | 2.69 | 2.64 | 2.60 | 2.55 | 2.51 | 2.47 | 2.42 | 2.38 | 2.33 | 2.29 | 2.25 |
| 58.5 | 3.00 | 3.18 | 3.26 | 3.22 | 3.17 | 3.13 | 3.09 | 3.04 | 3.00 | 2.95 | 2.91 | 2.87 | 2.82 | 2.78 | 2.73 | 2.69 | 2.65 | 2.60 | 2.56 | 2.51 | 2.47 | 2.43 | 2.38 | 2.34 | 2.29 |
| 59.0 | 3.04 | 3.22 | 3.31 | 3.26 | 3.22 | 3.18 | 3.13 | 3.09 | 3.04 | 3.00 | 2.96 | 2.91 | 2.87 | 2.82 | 2.78 | 2.74 | 2.69 | 2.65 | 2.60 | 2.56 | 2.52 | 2.47 | 2.43 | 2.38 | 2.34 |
| 59.5 | 3.08 | 3.27 | 3.36 | 3.31 | 3.27 | 3.23 | 3.18 | 3.14 | 3.09 | 3.05 | 3.00 | 2.96 | 2.92 | 2.87 | 2.83 | 2.78 | 2.74 | 2.70 | 2.65 | 2.61 | 2.56 | 2.52 | 2.48 | 2.43 | 2.39 |
| 60.0 | 3.12 | 3.31 | 3.40 | 3.36 | 3.31 | 3.27 | 3.23 | 3.18 | 3.14 | 3.09 | 3.05 | 3.01 | 2.96 | 2.92 | 2.87 | 2.83 | 2.79 | 2.74 | 2.70 | 2.65 | 2.61 | 2.57 | 2.52 | 2.48 | 2.43 |
| 60.5 | 3.17 | 3.35 | 3.45 | 3.41 | 3.36 | 3.32 | 3.27 | 3.23 | 3.19 | 3.14 | 3.10 | 3.05 | 3.01 | 2.97 | 2.92 | 2.88 | 2.83 | 2.79 | 2.75 | 2.70 | 2.66 | 2.61 | 2.57 | 2.53 | 2.48 |
| 61.0 | 3.21 | 3.39 | 3.50 | 3.45 | 3.41 | 3.36 | 3.32 | 3.28 | 3.23 | 3.19 | 3.14 | 3.10 | 3.06 | 3.01 | 2.97 | 2.92 | 2.88 | 2.84 | 2.79 | 2.75 | 2.70 | 2.66 | 2.62 | 2.57 | 2.53 |
| 61.5 | 3.25 | 3.43 | 3.54 | 3.50 | 3.46 | 3.41 | 3.37 | 3.32 | 3.28 | 3.24 | 3.19 | 3.15 | 3.10 | 3.06 | 3.02 | 2.97 | 2.93 | 2.88 | 2.84 | 2.80 | 2.75 | 2.71 | 2.66 | 2.62 | 2.58 |
| 62.0 | 3.29 | 3.48 | 3.59 | 3.55 | 3.50 | 3.46 | 3.41 | 3.37 | 3.33 | 3.28 | 3.24 | 3.19 | 3.15 | 3.11 | 3.06 | 3.02 | 2.97 | 2.93 | 2.89 | 2.84 | 2.80 | 2.75 | 2.71 | 2.67 | 2.62 |
| 62.5 | 3.33 | 3.52 | 3.64 | 3.59 | 3.55 | 3.51 | 3.46 | 3.42 | 3.37 | 3.33 | 3.29 | 3.24 | 3.20 | 3.15 | 3.11 | 3.07 | 3.02 | 2.98 | 2.93 | 2.89 | 2.85 | 2.80 | 2.76 | 2.71 | 2.67 |
| 63.0 | 3.38 | 3.56 | 3.68 | 3.64 | 3.60 | 3.55 | 3.51 | 3.46 | 3.42 | 3.38 | 3.33 | 3.29 | 3.24 | 3.20 | 3.16 | 3.11 | 3.07 | 3.02 | 2.98 | 2.94 | 2.89 | 2.85 | 2.80 | 2.76 | 2.72 |
| 63.5 | 3.42 | 3.60 | 3.73 | 3.69 | 3.64 | 3.60 | 3.56 | 3.51 | 3.47 | 3.42 | 3.38 | 3.34 | 3.29 | 3.25 | 3.20 | 3.16 | 3.12 | 3.07 | 3.03 | 2.98 | 2.94 | 2.90 | 2.85 | 2.81 | 2.76 |
| 64.0 | 3.46 | 3.64 | 3.78 | 3.73 | 3.69 | 3.65 | 3.60 | 3.56 | 3.51 | 3.47 | 3.43 | 3.38 | 3.34 | 3.29 | 3.25 | 3.21 | 3.16 | 3.12 | 3.07 | 3.03 | 2.99 | 2.94 | 2.90 | 2.85 | 2.81 |
| 64.5 | 3.50 | 3.69 | 3.83 | 3.78 | 3.74 | 3.69 | 3.65 | 3.61 | 3.56 | 3.52 | 3.47 | 3.43 | 3.39 | 3.34 | 3.30 | 3.25 | 3.21 | 3.17 | 3.12 | 3.08 | 3.03 | 2.99 | 2.95 | 2.90 | 2.86 |
| 65.0 | 3.54 | 3.73 | 3.87 | 3.83 | 3.78 | 3.74 | 3.70 | 3.65 | 3.61 | 3.56 | 3.52 | 3.48 | 3.43 | 3.39 | 3.34 | 3.30 | 3.26 | 3.21 | 3.17 | 3.12 | 3.08 | 3.04 | 2.99 | 2.95 | 2.90 |
| 65.5 | 3.59 | 3.77 | 3.92 | 3.88 | 3.83 | 3.79 | 3.74 | 3.70 | 3.66 | 3.61 | 3.57 | 3.52 | 3.48 | 3.44 | 3.39 | 3.35 | 3.30 | 3.26 | 3.22 | 3.17 | 3.13 | 3.08 | 3.04 | 3.00 | 2.95 |
| 66.0 | 3.63 | 3.81 | 3.97 | 3.92 | 3.88 | 3.83 | 3.79 | 3.75 | 3.70 | 3.66 | 3.61 | 3.57 | 3.53 | 3.48 | 3.44 | 3.39 | 3.35 | 3.31 | 3.26 | 3.22 | 3.17 | 3.13 | 3.09 | 3.04 | 3.00 |
| 66.5 | 3.67 | 3.85 | 4.01 | 3.97 | 3.93 | 3.88 | 3.84 | 3.79 | 3.75 | 3.71 | 3.66 | 3.62 | 3.57 | 3.53 | 3.49 | 3.44 | 3.40 | 3.35 | 3.31 | 3.27 | 3.22 | 3.18 | 3.13 | 3.09 | 3.05 |
| 67.0 | 3.71 | 3.89 | 4.06 | 4.02 | 3.97 | 3.93 | 3.88 | 3.84 | 3.80 | 3.75 | 3.71 | 3.66 | 3.62 | 3.58 | 3.53 | 3.49 | 3.44 | 3.40 | 3.36 | 3.31 | 3.27 | 3.22 | 3.18 | 3.14 | 3.09 |
| 67.5 | 3.75 | 3.94 | 4.11 | 4.06 | 4.02 | 3.98 | 3.93 | 3.89 | 3.84 | 3.80 | 3.76 | 3.71 | 3.67 | 3.62 | 3.58 | 3.54 | 3.49 | 3.45 | 3.40 | 3.36 | 3.32 | 3.27 | 3.23 | 3.18 | 3.14 |
| 68.0 | 3.79 | 3.98 | 4.15 | 4.11 | 4.07 | 4.02 | 3.98 | 3.93 | 3.89 | 3.85 | 3.80 | 3.76 | 3.71 | 3.67 | 3.63 | 3.58 | 3.54 | 3.49 | 3.45 | 3.41 | 3.36 | 3.32 | 3.27 | 3.23 | 3.19 |
| 68.5 | 3.84 | 4.02 | 4.20 | 4.16 | 4.11 | 4.07 | 4.03 | 3.98 | 3.94 | 3.89 | 3.85 | 3.81 | 3.76 | 3.72 | 3.67 | 3.63 | 3.59 | 3.54 | 3.50 | 3.45 | 3.41 | 3.37 | 3.32 | 3.28 | 3.23 |
| 69.0 | 3.88 | 4.06 | 4.25 | 4.20 | 4.16 | 4.12 | 4.07 | 4.03 | 3.98 | 3.94 | 3.90 | 3.85 | 3.81 | 3.76 | 3.72 | 3.68 | 3.63 | 3.59 | 3.54 | 3.50 | 3.46 | 3.41 | 3.37 | 3.32 | 3.28 |
| 69.5 | 3.92 | 4.10 | 4.30 | 4.25 | 4.21 | 4.16 | 4.12 | 4.08 | 4.03 | 3.99 | 3.94 | 3.90 | 3.86 | 3.81 | 3.77 | 3.72 | 3.68 | 3.64 | 3.59 | 3.55 | 3.50 | 3.46 | 3.42 | 3.37 | 3.33 |
| 70.0 | 3.96 | 4.15 | 4.34 | 4.30 | 4.25 | 4.21 | 4.17 | 4.12 | 4.08 | 4.03 | 3.99 | 3.95 | 3.90 | 3.86 | 3.81 | 3.77 | 3.73 | 3.68 | 3.64 | 3.59 | 3.55 | 3.51 | 3.46 | 3.42 | 3.37 |
| 70.5 | 4.00 | 4.19 | 4.39 | 4.35 | 4.30 | 4.26 | 4.21 | 4.17 | 4.13 | 4.08 | 4.04 | 3.99 | 3.95 | 3.91 | 3.86 | 3.82 | 3.77 | 3.73 | 3.69 | 3.64 | 3.60 | 3.55 | 3.51 | 3.47 | 3.42 |
| 71.0 | 4.05 | 4.23 | 4.44 | 4.39 | 4.35 | 4.30 | 4.26 | 4.22 | 4.17 | 4.13 | 4.08 | 4.04 | 4.00 | 3.95 | 3.91 | 3.86 | 3.82 | 3.78 | 3.73 | 3.69 | 3.64 | 3.60 | 3.56 | 3.51 | 3.47 |
| 71.5 | 4.09 | 4.27 | 4.48 | 4.44 | 4.40 | 4.35 | 4.31 | 4.26 | 4.22 | 4.18 | 4.13 | 4.09 | 4.04 | 4.00 | 3.96 | 3.91 | 3.87 | 3.82 | 3.78 | 3.74 | 3.69 | 3.65 | 3.60 | 3.56 | 3.52 |
| 72.0 | 4.13 | 4.31 | 4.53 | 4.49 | 4.44 | 4.40 | 4.35 | 4.31 | 4.27 | 4.22 | 4.18 | 4.13 | 4.09 | 4.05 | 4.00 | 3.96 | 3.91 | 3.87 | 3.83 | 3.78 | 3.74 | 3.69 | 3.65 | 3.61 | 3.56 |
| 72.5 | 4.17 | 4.36 | 4.58 | 4.53 | 4.49 | 4.45 | 4.40 | 4.36 | 4.31 | 4.27 | 4.23 | 4.18 | 4.14 | 4.09 | 4.05 | 4.01 | 3.96 | 3.92 | 3.87 | 3.83 | 3.79 | 3.74 | 3.70 | 3.65 | 3.61 |
| 73.0 | 4.21 | 4.40 | 4.62 | 4.58 | 4.54 | 4.49 | 4.45 | 4.40 | 4.36 | 4.32 | 4.27 | 4.23 | 4.18 | 4.14 | 4.10 | 4.05 | 4.01 | 3.96 | 3.92 | 3.88 | 3.83 | 3.79 | 3.74 | 3.70 | 3.66 |
| 73.5 | 4.26 | 4.44 | 4.67 | 4.63 | 4.58 | 4.54 | 4.50 | 4.45 | 4.41 | 4.36 | 4.32 | 4.28 | 4.23 | 4.19 | 4.14 | 4.10 | 4.06 | 4.01 | 3.97 | 3.92 | 3.88 | 3.84 | 3.79 | 3.75 | 3.70 |
| 74.0 | 4.30 | 4.48 | 4.72 | 4.67 | 4.63 | 4.59 | 4.54 | 4.50 | 4.45 | 4.41 | 4.37 | 4.32 | 4.28 | 4.23 | 4.19 | 4.15 | 4.10 | 4.06 | 4.01 | 3.97 | 3.93 | 3.88 | 3.84 | 3.79 | 3.75 |
| 74.5 | 4.34 | 4.52 | 4.77 | 4.72 | 4.68 | 4.63 | 4.59 | 4.55 | 4.50 | 4.46 | 4.41 | 4.37 | 4.33 | 4.28 | 4.24 | 4.19 | 4.15 | 4.11 | 4.06 | 4.02 | 3.97 | 3.93 | 3.89 | 3.84 | 3.80 |
| 75.0 | 4.38 | 4.57 | 4.81 | 4.77 | 4.72 | 4.68 | 4.64 | 4.59 | 4.55 | 4.50 | 4.46 | 4.42 | 4.37 | 4.33 | 4.28 | 4.24 | 4.20 | 4.15 | 4.11 | 4.06 | 4.02 | 3.98 | 3.93 | 3.89 | 3.84 |
| 75.5 | 4.42 | 4.61 | 4.86 | 4.82 | 4.77 | 4.73 | 4.68 | 4.64 | 4.60 | 4.55 | 4.51 | 4.46 | 4.42 | 4.38 | 4.33 | 4.29 | 4.24 | 4.20 | 4.16 | 4.11 | 4.07 | 4.02 | 3.98 | 3.94 | 3.89 |
| 76.0 | 4.47 | 4.65 | 4.91 | 4.86 | 4.82 | 4.77 | 4.73 | 4.69 | 4.64 | 4.60 | 4.55 | 4.51 | 4.47 | 4.42 | 4.38 | 4.33 | 4.29 | 4.25 | 4.20 | 4.16 | 4.11 | 4.07 | 4.03 | 3.98 | 3.94 |
| 76.5 | 4.51 | 4.69 | 4.95 | 4.91 | 4.87 | 4.82 | 4.78 | 4.73 | 4.69 | 4.65 | 4.60 | 4.56 | 4.51 | 4.47 | 4.42 | 4.38 | 4.34 | 4.29 | 4.25 | 4.21 | 4.16 | 4.12 | 4.07 | 4.03 | 3.99 |
| 77.0 | 4.55 | 4.73 | 5.00 | 4.96 | 4.91 | 4.87 | 4.82 | 4.78 | 4.74 | 4.69 | 4.65 | 4.60 | 4.56 | 4.52 | 4.47 | 4.43 | 4.38 | 4.34 | 4.30 | 4.25 | 4.21 | 4.16 | 4.12 | 4.08 | 4.03 |

TABLE 4. PREDICTED FEV1 FOR FEMALES (KNUDSON, ET AL: AM REV RESPIR DIS. 1976, 113, 587.)

| AGE / HT | 17 | 19 | 21 | 23 | 25 | 27 | 29 | 31 | 33 | 35 | 37 | 39 | 41 | 43 | 45 | 47 | 49 | 51 | 53 | 55 | 57 | 59 | 61 | 63 | 65 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 52.0 | 2.31 | 2.48 | 2.33 | 2.29 | 2.25 | 2.21 | 2.16 | 2.12 | 2.08 | 2.04 | 2.00 | 1.95 | 1.91 | 1.87 | 1.83 | 1.79 | 1.74 | 1.70 | 1.66 | 1.62 | 1.58 | 1.53 | 1.49 | 1.45 | 1.41 |
| 52.5 | 2.34 | 2.51 | 2.37 | 2.32 | 2.28 | 2.24 | 2.20 | 2.16 | 2.11 | 2.07 | 2.03 | 1.99 | 1.95 | 1.90 | 1.86 | 1.82 | 1.78 | 1.74 | 1.69 | 1.65 | 1.61 | 1.57 | 1.53 | 1.48 | 1.44 |
| 53.0 | 2.38 | 2.55 | 2.40 | 2.36 | 2.32 | 2.27 | 2.23 | 2.19 | 2.15 | 2.11 | 2.06 | 2.02 | 1.98 | 1.94 | 1.90 | 1.85 | 1.81 | 1.77 | 1.73 | 1.69 | 1.64 | 1.60 | 1.56 | 1.52 | 1.48 |
| 53.5 | 2.41 | 2.58 | 2.43 | 2.39 | 2.35 | 2.31 | 2.27 | 2.22 | 2.18 | 2.14 | 2.10 | 2.06 | 2.01 | 1.97 | 1.93 | 1.89 | 1.85 | 1.80 | 1.76 | 1.72 | 1.68 | 1.64 | 1.59 | 1.55 | 1.51 |
| 54.0 | 2.45 | 2.62 | 2.47 | 2.43 | 2.38 | 2.34 | 2.30 | 2.26 | 2.22 | 2.17 | 2.13 | 2.09 | 2.05 | 2.01 | 1.96 | 1.92 | 1.88 | 1.84 | 1.80 | 1.75 | 1.71 | 1.67 | 1.63 | 1.59 | 1.54 |
| 54.5 | 2.48 | 2.65 | 2.50 | 2.46 | 2.42 | 2.38 | 2.33 | 2.29 | 2.25 | 2.21 | 2.17 | 2.12 | 2.08 | 2.04 | 2.00 | 1.96 | 1.91 | 1.87 | 1.83 | 1.79 | 1.75 | 1.70 | 1.66 | 1.62 | 1.58 |
| 55.0 | 2.51 | 2.68 | 2.54 | 2.49 | 2.45 | 2.41 | 2.37 | 2.33 | 2.28 | 2.24 | 2.20 | 2.16 | 2.12 | 2.07 | 2.03 | 1.99 | 1.95 | 1.91 | 1.86 | 1.82 | 1.78 | 1.74 | 1.70 | 1.65 | 1.61 |
| 55.5 | 2.55 | 2.72 | 2.57 | 2.53 | 2.49 | 2.45 | 2.40 | 2.36 | 2.32 | 2.28 | 2.24 | 2.19 | 2.15 | 2.11 | 2.07 | 2.03 | 1.98 | 1.94 | 1.90 | 1.86 | 1.82 | 1.77 | 1.73 | 1.69 | 1.65 |
| 56.0 | 2.58 | 2.75 | 2.61 | 2.56 | 2.52 | 2.48 | 2.44 | 2.40 | 2.35 | 2.31 | 2.27 | 2.23 | 2.19 | 2.14 | 2.10 | 2.06 | 2.02 | 1.98 | 1.93 | 1.89 | 1.85 | 1.81 | 1.77 | 1.72 | 1.68 |
| 56.5 | 2.62 | 2.79 | 2.64 | 2.60 | 2.56 | 2.51 | 2.47 | 2.43 | 2.39 | 2.35 | 2.30 | 2.26 | 2.22 | 2.18 | 2.14 | 2.09 | 2.05 | 2.01 | 1.97 | 1.93 | 1.88 | 1.84 | 1.80 | 1.76 | 1.72 |
| 57.0 | 2.65 | 2.82 | 2.67 | 2.63 | 2.59 | 2.55 | 2.51 | 2.46 | 2.42 | 2.38 | 2.34 | 2.30 | 2.25 | 2.21 | 2.17 | 2.13 | 2.09 | 2.04 | 2.00 | 1.96 | 1.92 | 1.88 | 1.83 | 1.79 | 1.75 |
| 57.5 | 2.69 | 2.86 | 2.71 | 2.67 | 2.62 | 2.58 | 2.54 | 2.50 | 2.46 | 2.41 | 2.37 | 2.33 | 2.29 | 2.25 | 2.20 | 2.16 | 2.12 | 2.08 | 2.04 | 1.99 | 1.95 | 1.91 | 1.87 | 1.83 | 1.78 |
| 58.0 | 2.72 | 2.89 | 2.74 | 2.70 | 2.66 | 2.62 | 2.57 | 2.53 | 2.49 | 2.45 | 2.41 | 2.36 | 2.32 | 2.28 | 2.24 | 2.20 | 2.15 | 2.11 | 2.07 | 2.03 | 1.99 | 1.94 | 1.90 | 1.86 | 1.82 |
| 58.5 | 2.75 | 2.92 | 2.78 | 2.73 | 2.69 | 2.65 | 2.61 | 2.57 | 2.52 | 2.48 | 2.44 | 2.40 | 2.36 | 2.31 | 2.27 | 2.23 | 2.19 | 2.15 | 2.10 | 2.06 | 2.02 | 1.98 | 1.94 | 1.89 | 1.85 |
| 59.0 | 2.79 | 2.96 | 2.81 | 2.77 | 2.73 | 2.69 | 2.64 | 2.60 | 2.56 | 2.52 | 2.48 | 2.43 | 2.39 | 2.35 | 2.31 | 2.27 | 2.22 | 2.18 | 2.14 | 2.10 | 2.06 | 2.01 | 1.97 | 1.93 | 1.89 |
| 59.5 | 2.82 | 2.99 | 2.85 | 2.80 | 2.76 | 2.72 | 2.68 | 2.64 | 2.59 | 2.55 | 2.51 | 2.47 | 2.43 | 2.38 | 2.34 | 2.30 | 2.26 | 2.22 | 2.17 | 2.13 | 2.09 | 2.05 | 2.01 | 1.96 | 1.92 |
| 60.0 | 2.86 | 3.03 | 2.88 | 2.84 | 2.80 | 2.75 | 2.71 | 2.67 | 2.63 | 2.59 | 2.54 | 2.50 | 2.46 | 2.42 | 2.38 | 2.33 | 2.29 | 2.25 | 2.21 | 2.17 | 2.12 | 2.08 | 2.04 | 2.00 | 1.96 |
| 60.5 | 2.89 | 3.06 | 2.91 | 2.87 | 2.83 | 2.79 | 2.75 | 2.70 | 2.66 | 2.62 | 2.58 | 2.54 | 2.49 | 2.45 | 2.41 | 2.37 | 2.33 | 2.28 | 2.24 | 2.20 | 2.16 | 2.12 | 2.07 | 2.03 | 1.99 |
| 61.0 | 2.93 | 3.10 | 2.95 | 2.91 | 2.86 | 2.82 | 2.78 | 2.74 | 2.70 | 2.65 | 2.61 | 2.57 | 2.53 | 2.49 | 2.44 | 2.40 | 2.36 | 2.32 | 2.28 | 2.23 | 2.19 | 2.15 | 2.11 | 2.07 | 2.02 |
| 61.5 | 2.96 | 3.13 | 2.98 | 2.94 | 2.90 | 2.86 | 2.81 | 2.77 | 2.73 | 2.69 | 2.65 | 2.60 | 2.56 | 2.52 | 2.48 | 2.44 | 2.39 | 2.35 | 2.31 | 2.27 | 2.23 | 2.18 | 2.14 | 2.10 | 2.06 |
| 62.0 | 2.99 | 3.16 | 3.02 | 2.97 | 2.93 | 2.89 | 2.85 | 2.81 | 2.76 | 2.72 | 2.68 | 2.64 | 2.60 | 2.55 | 2.51 | 2.47 | 2.43 | 2.39 | 2.34 | 2.30 | 2.26 | 2.22 | 2.18 | 2.13 | 2.09 |
| 62.5 | 3.03 | 3.20 | 3.05 | 3.01 | 2.97 | 2.93 | 2.88 | 2.84 | 2.80 | 2.76 | 2.72 | 2.67 | 2.63 | 2.59 | 2.55 | 2.51 | 2.46 | 2.42 | 2.38 | 2.34 | 2.30 | 2.25 | 2.21 | 2.17 | 2.13 |
| 63.0 | 3.06 | 3.23 | 3.09 | 3.04 | 3.00 | 2.96 | 2.92 | 2.88 | 2.83 | 2.79 | 2.75 | 2.71 | 2.67 | 2.62 | 2.58 | 2.54 | 2.50 | 2.46 | 2.41 | 2.37 | 2.33 | 2.29 | 2.25 | 2.20 | 2.16 |
| 63.5 | 3.10 | 3.27 | 3.12 | 3.08 | 3.04 | 2.99 | 2.95 | 2.91 | 2.87 | 2.83 | 2.78 | 2.74 | 2.70 | 2.66 | 2.62 | 2.57 | 2.53 | 2.49 | 2.45 | 2.41 | 2.36 | 2.32 | 2.28 | 2.24 | 2.20 |
| 64.0 | 3.13 | 3.30 | 3.15 | 3.11 | 3.07 | 3.03 | 2.99 | 2.94 | 2.90 | 2.86 | 2.82 | 2.78 | 2.73 | 2.69 | 2.65 | 2.61 | 2.57 | 2.52 | 2.48 | 2.44 | 2.40 | 2.36 | 2.31 | 2.27 | 2.23 |
| 64.5 | 3.17 | 3.34 | 3.19 | 3.15 | 3.10 | 3.06 | 3.02 | 2.98 | 2.94 | 2.89 | 2.85 | 2.81 | 2.77 | 2.73 | 2.68 | 2.64 | 2.60 | 2.56 | 2.52 | 2.47 | 2.43 | 2.39 | 2.35 | 2.31 | 2.26 |
| 65.0 | 3.20 | 3.37 | 3.22 | 3.18 | 3.14 | 3.10 | 3.05 | 3.01 | 2.97 | 2.93 | 2.89 | 2.84 | 2.80 | 2.76 | 2.72 | 2.68 | 2.63 | 2.59 | 2.55 | 2.51 | 2.47 | 2.42 | 2.38 | 2.34 | 2.30 |
| 65.5 | 3.23 | 3.40 | 3.26 | 3.21 | 3.17 | 3.13 | 3.09 | 3.05 | 3.00 | 2.96 | 2.92 | 2.88 | 2.84 | 2.79 | 2.75 | 2.71 | 2.67 | 2.63 | 2.58 | 2.54 | 2.50 | 2.46 | 2.42 | 2.37 | 2.33 |
| 66.0 | 3.27 | 3.44 | 3.29 | 3.25 | 3.21 | 3.17 | 3.12 | 3.08 | 3.04 | 3.00 | 2.96 | 2.91 | 2.87 | 2.83 | 2.79 | 2.75 | 2.70 | 2.66 | 2.62 | 2.58 | 2.54 | 2.49 | 2.45 | 2.41 | 2.37 |
| 66.5 | 3.30 | 3.47 | 3.33 | 3.28 | 3.24 | 3.20 | 3.16 | 3.12 | 3.07 | 3.03 | 2.99 | 2.95 | 2.91 | 2.86 | 2.82 | 2.78 | 2.74 | 2.70 | 2.65 | 2.61 | 2.57 | 2.53 | 2.49 | 2.44 | 2.40 |
| 67.0 | 3.34 | 3.51 | 3.36 | 3.32 | 3.28 | 3.23 | 3.19 | 3.15 | 3.11 | 3.07 | 3.02 | 2.98 | 2.94 | 2.90 | 2.86 | 2.81 | 2.77 | 2.73 | 2.69 | 2.65 | 2.60 | 2.56 | 2.52 | 2.48 | 2.44 |
| 67.5 | 3.37 | 3.54 | 3.39 | 3.35 | 3.31 | 3.27 | 3.23 | 3.18 | 3.14 | 3.10 | 3.06 | 3.02 | 2.97 | 2.93 | 2.89 | 2.85 | 2.81 | 2.76 | 2.72 | 2.68 | 2.64 | 2.60 | 2.55 | 2.51 | 2.47 |
| 68.0 | 3.41 | 3.58 | 3.43 | 3.39 | 3.34 | 3.30 | 3.26 | 3.22 | 3.18 | 3.13 | 3.09 | 3.05 | 3.01 | 2.97 | 2.92 | 2.88 | 2.84 | 2.80 | 2.76 | 2.71 | 2.67 | 2.63 | 2.59 | 2.55 | 2.50 |
| 68.5 | 3.44 | 3.61 | 3.46 | 3.42 | 3.38 | 3.34 | 3.29 | 3.25 | 3.21 | 3.17 | 3.13 | 3.08 | 3.04 | 3.00 | 2.96 | 2.92 | 2.87 | 2.83 | 2.79 | 2.75 | 2.71 | 2.66 | 2.62 | 2.58 | 2.54 |
| 69.0 | 3.47 | 3.64 | 3.50 | 3.46 | 3.41 | 3.37 | 3.33 | 3.29 | 3.25 | 3.20 | 3.16 | 3.12 | 3.08 | 3.04 | 2.99 | 2.95 | 2.91 | 2.87 | 2.83 | 2.78 | 2.74 | 2.70 | 2.66 | 2.62 | 2.57 |
| 69.5 | 3.51 | 3.68 | 3.53 | 3.49 | 3.45 | 3.41 | 3.36 | 3.32 | 3.28 | 3.24 | 3.20 | 3.15 | 3.11 | 3.07 | 3.03 | 2.99 | 2.94 | 2.90 | 2.86 | 2.82 | 2.78 | 2.73 | 2.69 | 2.65 | 2.61 |
| 70.0 | 3.54 | 3.71 | 3.57 | 3.52 | 3.48 | 3.44 | 3.40 | 3.36 | 3.31 | 3.27 | 3.23 | 3.19 | 3.15 | 3.10 | 3.06 | 3.02 | 2.98 | 2.94 | 2.89 | 2.85 | 2.81 | 2.77 | 2.73 | 2.68 | 2.64 |
| 70.5 | 3.58 | 3.75 | 3.60 | 3.56 | 3.52 | 3.47 | 3.43 | 3.39 | 3.35 | 3.31 | 3.26 | 3.22 | 3.18 | 3.14 | 3.10 | 3.05 | 3.01 | 2.97 | 2.93 | 2.89 | 2.84 | 2.80 | 2.76 | 2.72 | 2.68 |
| 71.0 | 3.61 | 3.78 | 3.63 | 3.59 | 3.55 | 3.51 | 3.47 | 3.42 | 3.38 | 3.34 | 3.30 | 3.26 | 3.21 | 3.17 | 3.13 | 3.09 | 3.05 | 3.00 | 2.96 | 2.92 | 2.88 | 2.84 | 2.79 | 2.75 | 2.71 |
| 71.5 | 3.65 | 3.82 | 3.67 | 3.63 | 3.58 | 3.54 | 3.50 | 3.46 | 3.42 | 3.37 | 3.33 | 3.29 | 3.25 | 3.21 | 3.16 | 3.12 | 3.08 | 3.04 | 3.00 | 2.95 | 2.91 | 2.87 | 2.83 | 2.79 | 2.74 |
| 72.0 | 3.68 | 3.85 | 3.70 | 3.66 | 3.62 | 3.58 | 3.53 | 3.49 | 3.45 | 3.41 | 3.37 | 3.32 | 3.28 | 3.24 | 3.20 | 3.16 | 3.11 | 3.07 | 3.03 | 2.99 | 2.95 | 2.90 | 2.86 | 2.82 | 2.78 |
| 72.5 | 3.71 | 3.88 | 3.74 | 3.70 | 3.65 | 3.61 | 3.57 | 3.53 | 3.49 | 3.44 | 3.40 | 3.36 | 3.32 | 3.28 | 3.23 | 3.19 | 3.15 | 3.11 | 3.07 | 3.02 | 2.98 | 2.94 | 2.90 | 2.86 | 2.81 |
| 73.0 | 3.75 | 3.92 | 3.77 | 3.73 | 3.69 | 3.65 | 3.60 | 3.56 | 3.52 | 3.48 | 3.44 | 3.39 | 3.35 | 3.31 | 3.27 | 3.23 | 3.18 | 3.14 | 3.10 | 3.06 | 3.02 | 2.97 | 2.93 | 2.89 | 2.85 |
| 73.5 | 3.78 | 3.95 | 3.81 | 3.76 | 3.72 | 3.68 | 3.64 | 3.60 | 3.55 | 3.51 | 3.47 | 3.43 | 3.39 | 3.34 | 3.30 | 3.26 | 3.22 | 3.18 | 3.13 | 3.09 | 3.05 | 3.01 | 2.97 | 2.92 | 2.88 |
| 74.0 | 3.82 | 3.99 | 3.84 | 3.80 | 3.76 | 3.71 | 3.67 | 3.63 | 3.59 | 3.55 | 3.50 | 3.46 | 3.42 | 3.38 | 3.34 | 3.29 | 3.25 | 3.21 | 3.17 | 3.13 | 3.08 | 3.04 | 3.00 | 2.96 | 2.92 |
| 74.5 | 3.85 | 4.02 | 3.87 | 3.83 | 3.79 | 3.75 | 3.71 | 3.66 | 3.62 | 3.58 | 3.54 | 3.50 | 3.45 | 3.41 | 3.37 | 3.33 | 3.29 | 3.24 | 3.20 | 3.16 | 3.12 | 3.08 | 3.03 | 2.99 | 2.95 |
| 75.0 | 3.89 | 4.06 | 3.91 | 3.87 | 3.82 | 3.78 | 3.74 | 3.70 | 3.66 | 3.61 | 3.57 | 3.53 | 3.49 | 3.45 | 3.40 | 3.36 | 3.32 | 3.28 | 3.24 | 3.19 | 3.15 | 3.11 | 3.07 | 3.03 | 2.98 |
| 75.5 | 3.92 | 4.09 | 3.94 | 3.90 | 3.86 | 3.82 | 3.77 | 3.73 | 3.69 | 3.65 | 3.61 | 3.56 | 3.52 | 3.48 | 3.44 | 3.40 | 3.35 | 3.31 | 3.27 | 3.23 | 3.19 | 3.14 | 3.10 | 3.06 | 3.02 |
| 76.0 | 3.95 | 4.12 | 3.98 | 3.94 | 3.89 | 3.85 | 3.81 | 3.77 | 3.73 | 3.68 | 3.64 | 3.60 | 3.56 | 3.52 | 3.47 | 3.43 | 3.39 | 3.35 | 3.31 | 3.26 | 3.22 | 3.18 | 3.14 | 3.10 | 3.05 |
| 76.5 | 3.99 | 4.16 | 4.01 | 3.97 | 3.93 | 3.89 | 3.84 | 3.80 | 3.76 | 3.72 | 3.68 | 3.63 | 3.59 | 3.55 | 3.51 | 3.47 | 3.42 | 3.38 | 3.34 | 3.30 | 3.26 | 3.21 | 3.17 | 3.13 | 3.09 |
| 77.0 | 4.02 | 4.19 | 4.05 | 4.00 | 3.96 | 3.92 | 3.88 | 3.84 | 3.79 | 3.75 | 3.71 | 3.67 | 3.63 | 3.58 | 3.54 | 3.50 | 3.46 | 3.42 | 3.37 | 3.33 | 3.29 | 3.25 | 3.21 | 3.16 | 3.12 |

[4510-26-M]

APPENDIX D—PULMONARY FUNCTION STANDARDS FOR COTTON DUST STANDARD

The spirometric measurements of pulmonary function shall conform to the following minimum standards, and these standards are not intended to preclude additional testing or alternate methods which can be determined to be superior.

I. APPARATUS

a. The instrument shall be accurate to within ±50 milliliters or within ±3 percent of reading, whichever is greater.

b. The instrument should be capable of measuring vital capacity from 0 to 7 liters BTPS.

c. The instrument shall have a low inertia and offer low resistance to airflow such that the resistance to airflow at 12 liters per second must be less than 1.5 cm $H_2O$/(liter/sec).

d. The zero time point for the purpose of timing the $FEV_t$ shall be determined by extrapolating the steepest portion of the volume time curve back to the maximal inspiration volume (1, 2, 3, 4) or by an equivalent method.

e. Instruments incorporating measurements of airflow to determine volume shall conform to the same volume accuracy stated in (a) of this section when presented with flow rates from at least 0 to 12 liters per second.

f. The instrument or user of the instrument must have a means of correcting volumes to body temperature saturated with water vapor (BTPS) under conditions of varying ambient spirometer temperatures and barometric pressures.

g. The instrument used shall provide a tracing or display of either flow versus volume or volume versus time during the entire forced expiration. A tracing or display is necessary to determine whether the patient has performed the test properly. The tracing must be stored and available for recall and must be of sufficient size that hand measurements may be made within requirement of paragraph (a) of this section. If a paper record is made it must have a paper speed of at least 2 cm/sec and a volume sensitivity of at least 10.0 mm of chart per liter of volume.

h. The instrument shall be capable of accumulating for a minimum of 10 seconds and shall not stop accumulating volume before (1) the volume change for a 0.5 second interval is less than 25 milliliters, or (2) the flow is less than 50 milliliters per second for a 0.5 second interval.

i. The forced vital capacity (FVC) and forced expiratory volume in 1 second ($FEV^{1.0}$) measurements shall comply with the accuracy requirements stated in paragraph (a) of this section. That is, they should be accurately measured to within ±50 ml or within ±3 percent of reading, whichever is greater.

j. The instrument must be capable of being calibrated in the field with respect to the $FEV_t$ and FVC. This calibration of the $FEV_t$ and FVC may be either directly or indirectly through volume and time base measurements. The volume calibration source should provide a volume displacement of at least 2 liters and should be accurate to within ±30 milliliters.

II. TECHNIQUE FOR MEASUREMENT OF FORCED VITAL CAPACITY MANEUVER

a. Use of a nose clip is recommended but not required. The procedures shall be explained in simple terms to the patient who shall be instructed to loosen any tight clothing and stand in front of the apparatus. The subject may sit, but care should be taken on repeat testing that the same position be used and, if possible, the same spirometer. Particular attention shall be given to insure that the chin is slightly elevated with the neck slightly extended. The patient shall be instructed to make a full inspiration from a normal breathing pattern and then blow into the apparatus, without interruption, as hard, fast, and completely as possible. At least three forced expirations shall be carried out. During the maneuvers, the patient shall be observed for compliance with instructions. The expirations shall be checked visually for reproducibility from flow-volume or volume-time tracings or displays. The following efforts shall be judged unacceptable when the patient:

1. Has not reached full inspiration preceding the forced expiration,
2. Has not used maximal effort during the entire forced expiration,
3. Has not continued the expiration for at least 5 seconds or until an obvious plateau in the volume time curve has occurred,
4. Has coughed or closed his glottis,
5. Has an obstructed mouthpiece or a leak around the mouthpiece (obstruction due to tongue being placed in front of mouthpiece, false teeth falling in front of mouthpiece, etc.),
6. Has an unsatisfactory start of expiration, one characterized by excessive hesitation (or false starts), and therefore not allowing back extrapolation of time 0 (extrapolated volume on the volume time tracing must be less than 10 percent of the FVC).
7. Has an excessive variability between the three acceptable curves. The variation between the two largest FVC's and $FEV_t$'s of the three satisfactory tracings should not exceed 10 percent or ± 100 milliliters, whichever is greater.

b. Periodic and routine recalibration of the instrument or method for recording FVC and $FEV_{1.0}$ should be performed using a syringe or other volume source of at least 2 liters.

III. INTERPRETATION OF SPIROGRAM

a. The first step in evaluating a spirogram should be to determine whether or not the patient has performed the test properly or as described in II above. From the three satisfactory tracings, the forced vital capacity (FVC) and forced expiratory volume in 1 second ($FEV_{1.0}$) shall be measured and recorded. The largest observed FVC and largest observed $FEV_t$ shall be used in the analysis regardless of the curve(s) on which they occur.

b. The following guidelines are recommended by NIOSH for the evaluation and management of workers exposed to cotton dust. It is important to note that employees who show reductions in $FEV_t$/FVC ratio below .75 or drops in Monday $FEV_t$ of 5 percent or greater on their initial screening exam, should be re-evaluated within a month of the first exam. Those who show consistent decrease in lung function, as shown on the following table, should be managed as recommended.

IV. QUALIFICATIONS OF PERSONNEL ADMINISTERING THE TEST

Technicians who perform pulmonary function testing should have the basic knowledge required to produce meaningful results. Training consisting of approximately 16 hours of formal instruction should cover the following areas. Persons who successfully complete the course will be certified by OSHA or their designee.

a. Basic physiology of the forced vital capacity maneuver and the determinants of airflow limitation with emphasis on the relation to reproducibility of results.

b. Instrumentation requirements including calibration procedures, sources of error and their correction.

c. Performance of the testing including subject coaching, recognition of improperly performed maneuvers and corrective actions.

d. Data quality with emphasis on reproducibility.

e. Actual use of the equipment under supervised conditions.

f. Measurement of tracings and calculations of results.

---

**Supplement I—Text of other OSHA standards incorporated by reference in those Part 1910 standards identified as applicable to construction work**

SAFETY STANDARDS

Sec.
1910.23(e)(11) Wall opening screens.
1910.106(b) Tank storage.
1910.106(c) Piping, valves and fittings.
1910.110(b) Basic rules (LPG's).

**§ 1910.23 Guarding floor and wall openings and holes.**

* * * * *

(e) * * *

(11) Wall opening screens shall be of such construction and mounting that they are capable of withstanding a load of at least 200 pounds applied horizontally at any point on the near side of the screen. They may be of solid construction, of grillwork with openings not more than 8 inches long, or of slatwork with openings not more than 4 inches wide with length unrestricted.

* * * * *

**§ 1910.106 Flammable and combustible liquids.**

(b) *Tank storage*—(1) *Design and construction of tanks*—(i) *Materials.* (*a*) Tanks shall be built of steel except as provided in (*b*) through (*e*) of this subdivision.

(*b*) Tanks may be built of materials other than steel for installation underground or if required by the properties of the liquid stored. Tanks located above ground or inside buildings shall be of noncombustible construction.

(*c*) Tanks built of materials other than steel shall be designed to specifications embodying principles recognized as good engineering design for the material used.

(*d*) Unlined concrete tanks may be used for storing flammable or combus-

tible liquids having a gravity of 40° API or heavier. Concrete tanks with special lining may be used for other services provided the design is in accordance with sound engineering practice.

(e) Tanks may have combustible or noncombustible linings.

(f) Special engineering consideration shall be required if the specific gravity of the liquid to be stored exceeds that of water or if the tanks are designed to contain flammable or combustible liquids at a liquid temperature below 0° F.

(ii) *Fabrication.* (a) Tanks may be of any shape or type consistent with sound engineering design.

(b) Metal tanks shall be welded, riveted, and caulked, brazed, or bolted, or constructed by use of a combination of these methods. Filler metal used in brazing shall be nonferrous metal or an alloy having a melting point above 1000° F. and below that of the metal joined.

(iii) *Atmospheric tanks.* (a) Atmospheric tanks shall be built in accordance with acceptable good standards of design. Atmospheric tanks may be built in accordance with:

(1) Underwriters' Laboratories, Inc., Subjects No. 142, Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids, 1968; No. 58, Standard for Steel Underground Tanks for Flammable and Combustible Liquids, Fifth Edition, December 1961; or No. 80, Standard for Steel Inside Tanks for Oil-Burner Fuel, September 1963.

(2) American Petroleum Institute Standards No. 12A, Specification for Oil Storage Tanks with Riveted Shells, Seventh Edition, September 1951, or No. 650, Welded Steel Tanks for Oil Storage, Third Edition, 1966.

(3) American Petroleum Institute Standards No. 12B, Specification for Bolted Production Tanks, Eleventh Edition, May 1958, and Supplement 1, March 1962; No. 12D, Specification for Large Welded Production Tanks, Seventh Edition, August 1957; or No. 12F, Specification for Small Welded Production Tanks, Fifth Edition, March 1961. Tanks built in accordance with these standards shall be used only as production tanks for storage of crude petroleum in oil-producing areas.

(b) Tanks designed for underground service not exceeding 2,500 gallons capacity may be used aboveground.

(c) Low-pressure tanks and pressure vessels may be used as atmospheric tanks.

(d) Atmospheric tanks shall not be used for the storage of a flammable or combustible liquid at a temperature at or above its boiling point.

(iv) *Low pressure tanks.* (a) The normal operating pressure of the tank shall not exceed the design pressure of the tank.

(b) Low-pressure tanks shall be built in accordance with acceptable standards of design. Low-pressure tanks may be built in accordance with:

(1) American Petroleum Institute Standard No. 620, Recommended Rules for the Design and Construction of Large, Welded, Low-Pressure Storage Tanks, Third Edition, 1966.

(2) The principles of the Code for Unfired Pressure Vessels, Section VIII of the ASME Boiler and Pressure Vessels Code, 1968.

(c) Atmospheric tanks built according to Underwriters' Laboratories, Inc., requirements in subdivision (iii)(a) of this subparagraph may be used for operating pressures not exceeding 1 p. s. i.g. and shall be limited to 2.5 p.s.i.g. under emergency venting conditions.

(d) Pressure vessels may be used as low-pressure tanks.

(v) *Pressure vessels.* (a) The normal operating pressure of the vessel shall not exceed the design pressure of the vessel.

(b) Pressure vessels shall be built in accordance with the Code for Unfired Pressure Vessels, Section VIII of the ASME Boiler and Pressure Vessel Code 1968.

(vi) *Provisions for internal corrosion.* When tanks are not designed in accordance with the American Petroleum Institute, American Society of Mechanical Engineers, or the Underwriters' Laboratories, Inc.'s, standards, or if corrosion is anticipated beyond that provided for in the design formulas used, additional metal thickness or suitable protective coatings or linings shall be provided to compensate for the corrosion loss expected during the design life of the tank.

(2) *Installation of outside aboveground tanks*—(i) *Location with respect to property lines and public ways.* (a) Every aboveground tank for the storage of flammable or combustible liquids, except those liquids with boil-over characteristics and unstable liquids, operating at pressures not in excess of 2.5 p.s.i.g. and equipped with emergency venting which will not permit pressures to exceed 2.5 p.s.i.g. shall be located in accordance with Table H-5.

(b) Every aboveground tank for the storage of flammable or combustible liquids, except those liquids with boil-over characteristics and unstable flammable or combustible liquids, operating at pressures exceeding 2.5 p.s.i.g. or equipped with emergency venting which will permit pressures to exceed 2.5 p.s.i.g. shall be located in accordance with Table H-6.

(c) Every aboveground tank for the storage of flammable or combustible liquids with boil-over characteristics shall be located in accordance with Table H-7.

(d) Every aboveground tank for the storage of unstable liquids shall be located in accordance with Table H-8.

(e) Reference minimum distances for use in Tables H-5 to H-8, inclusive.

(f) Where end failure or horizontal pressure tanks and vessels may expose property, the tank shall be placed with the longitudinal axis parallel to the nearest important exposure.

(ii) *Spacing (shell-to-shell) between aboveground tanks.* (a) The distance between any two flammable or combustible liquid storage tanks shall not be less than 3 feet.

(b) Except as provided in subdivision (c) of this subdivision, the distance between any two adjacent tanks shall not be less than one-sixth the sum of their diameters. When the diameter of one tank is less than one-half the diameter of the adjacent tank, the distance between the two tanks shall not be less than one-half the diameter of the smaller tank.

(c) Where crude petroleum in conjunction with production facilities are located in noncongested areas and have capacities not exceeding 126,000 gallons (3,000 barrels), the distance between such tanks shall not be less than 3 feet.

(d) Where unstable flammable or combustible liquids are stored, the distance between such tanks shall not be less than one-half the sum of their diameters.

(e) When tanks are compacted in three or more rows or in an irregular pattern, greater spacing or other means shall be provided so that inside tanks are accessible for firefighting purposes.

(f) The minimum separation between a liquefied petroleum gas container and a flammable or combustible liquid storage tank shall be 20 feet, except in the case of flammable or combustible liquid tanks operating at pressures exceeding 2.5 p.s.i.g. or equipped with emergency venting which will permit pressures to exceed 2.5 p.s.i.g. in which case the provisions of subdivisions (a) and (b) of this subdivision shall apply. Suitable means shall be taken to prevent the accumulation of flammable or combustible liquids under adjacent liquefied petroleum gas containers such as by diversion curbs or grading. When flammable or combustible liquid storage tanks are within a diked area, the liquefied petroleum gas containers shall be outside the diked area and at least 10 feet away from the centerline of the wall of the diked area. The foregoing provisions shall not apply when liquefied petroleum gas containers of 125 gallons or less capacity are installed adjacent to fuel oil supply tanks of 550 gallons or less capacity.

withdrawal can be made, the vent size shall be based on the maximum anticipated simultaneous flow.

(*e*) Unless the vent is designed to limit the internal pressure 2.5 p.s.i. or less, the outlet of vents and vent drains shall be arranged to discharge in such a manner as to prevent localized overheating of any part of the tank in the event vapors from such vents are ignited.

(*f*) Tanks and pressure vessels storing Class IA liquids shall be equipped with venting devices which shall be normally closed except when venting to pressure or vacuum conditions. Tanks and pressure vessels storing Class IB and IC liquids shall be equipped with venting devices which shall be normally closed except when venting under pressure or vacuum conditions, or with approved flame arresters.

*Exemption:* Tanks of 3,000 bbls. capacity or less containing crude petroleum in crude-producing areas; and, outside aboveground atmospheric tanks under 1,000 gallons capacity containing other than Class IA flammable liquids may have open vents. (See subdivision (vi)(*b*) of this subparagraph.)

(*g*) Flame arresters or venting devices required in subdivision (*f*) of this subdivision may be omitted for Class IB and IC liquids where conditions are such that their use may, in case of obstruction, result in tank damage.

(v) *Emergency relief venting for fire exposure for aboveground tanks.* (*a*) Every aboveground storage tank shall have some form of construction or device that will relieve excessive internal pressure caused by exposure fires.

(*b*) In a vertical tank the construction referred to in subdivision (*a*) of this subdivision may take the form of a floating roof, lifter roof, a weak roof-to-shell seam, or other approved pressure relieving construction. The weak roof-to-shell seam shall be constructed to fail preferential to any other seam.

(*c*) Where entire dependence for emergency relief is placed upon pressure relieving devices, the total venting capacity of both normal and emergency vents shall be enough to prevent rupture of the shell or bottom of the tank if vertical, or of the shell or heads if horizontal. If unstable liquids are stored, the effects of heat or gas resulting from polymerization, decomposition, condensation, or self-reactivity shall be taken into account. The total capacity of both normal and emergency venting devices shall be not less than that derived from Table H-10 except as provided in subdivision (*e*) or (*f*) of this subdivision. Such device may be a self-closing manhole cover, or one using long bolts that permit the cover to lift under internal pressure, or an additional or larger relief valve or valves. The wetted area of the tank shall be calculated on the basis of 55 percent of the total exposed area of a sphere or spheroid, 75 percent of the total exposed area of a horizontal tank and the first 30 feet above grade of the exposed shell area of a vertical tank.

TABLE H-10—WETTED AREA VERSUS CUBIC FEET FREE AIR PER HOUR

(14.7 psia and 60° F.)

| Square feet | CFH | Square feet | CFH | Square feet | CFH |
|---|---|---|---|---|---|
| 20 | 21,100 | 200 | 211,000 | 1,000 | 524,000 |
| 30 | 31,600 | 250 | 239,000 | 1,200 | 557,000 |
| 40 | 42,100 | 300 | 265,000 | 1,400 | 587,000 |
| 50 | 52,700 | 350 | 288,000 | 1,600 | 614,000 |
| 60 | 63,200 | 400 | 312,000 | 1,800 | 639,000 |
| 70 | 73,700 | 500 | 354,000 | 2,000 | 662,000 |
| 80 | 84,200 | 600 | 392,000 | 2,400 | 704,000 |
| 90 | 94,800 | 700 | 428,000 | 2,800 | 742,000 |
| 100 | 105,000 | 800 | 462,000 | and | |
| 120 | 126,000 | 900 | 493,000 | over | |
| 140 | 147,000 | 1,000 | 524,000 | | |
| 160 | 168,000 | | | | |
| 180 | 190,000 | | | | |
| 200 | 211,000 | | | | |

(*d*) For tanks and storage vessels designed for pressure over 1 p.s.i.g., the total rate of venting shall be determined in accordance with Table H-10, except that when the exposed wetted area of the surface is greater than 2,800 square feet, the total rate of venting shall be calculated by the following formula:

$$CFH = 1{,}107A^{0.82}$$

Where:

$CFH$ = Venting requirement, in cubic feet of free air per hour.

$A$ = Exposed wetted surface, in square feet.

NOTE: The foregoing formula is based on $Q = 21{,}000^{0.82}$.

(*e*) The total emergency relief venting capacity for any specific stable liquid may be determined by the following formula:

$$V = 1337 \div L\sqrt{M}$$

$V$ = Cubic feet of free air per hour from Table H-10.

$L$ = Latent heat of vaporization of specific liquid in B.t.u. per pound.

$M$ = Molecular weight of specific liquids.

(*f*) The required airflow rate of subdivision (*c*) or (*e*) of this subdivision may be multiplied by the appropriate factor listed in the following schedule when protection is provided as indicated. Only one factor may be used for any one tank.

0.5 for drainage in accordance with subdivision (vii)(*b*) of this subparagraph for tanks over 200 square feet of wetted area.

0.3 for approved water spray.

0.3 for approved insulation.

0.15 for approved water spray with approved insulation.

(iii) *Location of outside aboveground tanks with respect to important buildings on same property.* Every outside aboveground tank shall be separated from important buildings on the same property by distances not less than those specified in subdivisions (i) (*a*), (*b*), (*c*), and (*d*) of this subparagraph, whichever is applicable. The appropriate distance column in Tables H-5, H-6, H-7, H-8, or H-9, that shall be used shall be the one reading: "Minimum Distance in Feet from Nearest Side of Any Public Way or From Nearest Important Building."

TABLE H-5

| Type of tank | Protection | Minimum distance in feet from property line which may be built upon, including the opposite side of a public way | Minimum distance in feet from nearest side of any public way or from nearest important building and shall be not less than 5 feet. |
|---|---|---|---|
| Floating roof | Protection for exposures. | ½ times diameter of tank but need not exceed 90 ft. | ⅛ times diameter of tank but need not exceed 30 ft. |
| | None | Diameter of tank but need not exceed 175 ft. | ⅛ times diameter of tank but need not exceed 30 ft. |
| Vertical with weak roof to shell seam. | Approved foam or inerting system on the tank. | ½ times diameter of tank but need not exceed 90 ft. and shall not be less than 5 ft. | ¼ times diameter of tank but need not exceed 30 ft. |
| | Protection for exposures. | Diameter of tank but need not exceed 175 ft. | ½ times diameter of tank but need not exceed 60 ft. |
| | None | 2 times diameter of tank but need not exceed 350 ft. | ½ times diameter of tank but need not exceed 60 ft. |
| Horizontal and vertical, with emergency relief venting to limit pressures to 2.5 p.s.i.g. | Approved inerting system on the tank or approved foam system on vertical tanks. | ½ times Table H-9 but shall not be less than 5 ft. | ½ times Table H-9. |
| | Protection for exposures. | Table H-9 | Table H-9. |
| | None | 2 times Table H-9 | Table H-9. |

TABLE H-6

| Type of tank | Protection | Minimum distance in feet from property line which may be built upon, including the opposite side of a public way | Minimum distance in feet from nearest side of any public way or from nearest important building |
|---|---|---|---|
| Any type | Protection for exposures. | 1½ times Table H-9 but shall not be less than 25 | 1½ times Table H-9 but shall not be less than 25 ft. |
| | None | 3 times Table H-9 but shall not be less than 50 ft. | 1½ times Table H-9 but shall not be less than 25 ft. |

TABLE H-7

| Type of tank | Protection | Minimum distance in feet from property line which may be built upon, including the opposite side of a public way | Minimum distance in feet from nearest side of any public way or from nearest important building |
|---|---|---|---|
| Floating roof | Protection for exposures. | Diameter of tank but need not exceed 175 ft. | ⅓ times diameter of tank but need not exceed 60 ft. |
| | None | 2 times diameter of tank but need not exceed 350 ft. | ⅓ times diameter of tank but need not exceed 60 ft. |
| Fixed roof | Approved foam or inerting system. | Diameter of tank but need not exceed 175 ft. | ⅓ times diameter of tank but need not exceed 60 ft. |
| | Protection for exposures. | 2 times diameter of tank but need not exceed 350 ft. | ⅔ times diameter of tank but need not exceed 120 ft. |
| | None | 4 times diameter of tank but need not exceed 350 ft. | ⅔ times diameter of tank but need not exceed 120 ft. |

TABLE H-8

| Type of tank | Protection | Minimum distance in feet from property line which may be built upon, including the opposite side of a public way | Minimum distance in feet from nearest side of any public way or from nearest important building |
|---|---|---|---|
| Horizontal and vertical tanks with emergency relief venting to permit pressure not in excess of 2.5 p.s.i.g. | Tank protected with any one of the following: Approved water spray, approved inerting, approved insulation and refrigeration, approved barricade. | See table H-9, but the distance may be not less than 25 ft. | Not less than 25 ft. |
| | Protection for exposures | 2½ times table H-9 but not less than 50 ft. | Not less than 50 ft. |
| | None | 5 times table H-9 but not less than 100 ft. | Not less than 100 ft. |
| Horizontal and vertical tanks with emergency relief venting to permit pressure over 2.5 p.s.i.g. | Tank protected with any one of the following: Approved water spray, approved inerting, approved insulation and refrigeration, approved barricade. | 2 times table H-9 but not less than 50 ft. | Not less than 50 ft. |
| | Protection for exposures | 4 times table H-9 but not less than 100 ft. | Not less than 100 ft. |
| | None | 8 times table H-9 but not less than 150 ft. | Not less than 150 ft. |

(iv) *Normal venting for aboveground tanks.* (*a*) Atmospheric storage tanks shall be adequately vented to prevent the development of vacuum or pressure sufficient to distort the roof of a cone roof tank or exceeding the design pressure in the case of other atmospheric tanks, as a result of filling or emptying, and atmospheric temperature changes.

(*b*) Normal vents shall be sized either in accordance with: (*1*) The American Petroleum Institute Standard 2000 (1968), Venting Atmospheric and Low-Pressure Storage Tanks; or (*2*) other accepted standard; or (*3*) shall be at least as large as the filling or withdrawal connection, whichever is larger but in no case less than 1¼ inch nominal inside diameter.

TABLE H-9

| Capacity tank gallons | Minimum distance in feet from property line which may be built upon, including the opposite side of a public way | Minimum distance in feet from nearest side of any public way or from nearest important building |
|---|---|---|
| 275 or less | 5 | 5 |
| 276 to 750 | 10 | 5 |
| 751 to 12,000 | 15 | 5 |
| 12,001 to 30,000 | 20 | 5 |
| 30,001 to 50,000 | 30 | 10 |
| 50,001 to 100,000 | 50 | 15 |
| 100,001 to 500,000 | 80 | 25 |
| 500,001 to 1,000,000 | 100 | 35 |
| 1,000,001 to 2,000,000 | 135 | 45 |
| 2,000,001 to 3,000,000 | 165 | 55 |
| 3,000,001 or more | 175 | 60 |

(*c*) Low-pressure tanks and pressure vessels shall be adequately vented to prevent development of pressure or vacuum, as a result of filling or emptying and atmospheric temperature changes, from exceeding the design pressure of the tank or vessel. Protection shall also be provided to prevent overpressure from any pump discharging into the tank or vessel when the pump discharge pressure can exceed the design pressure of the tank or vessel.

(*d*) If any tank or pressure vessel has more than one fill or withdrawal connection and simultaneous filling or

(g) The outlet of all vents and vent drains on tanks equipped with emergency venting to permit pressures exceeding 2.5 p.s.i.g. shall be arranged to discharge in such a way as to prevent localized overheating of any part of the tank, in the event vapors from such vents are ignited.

(h) Each commercial tank venting device shall have stamped on it the opening pressure, the pressure at which the valve reaches the full open position, and the flow capacity at the latter pressure, expressed in cubic feet per hour of air at 60° F. and at a pressure of 14.7 p.s.i.a.

(i) The flow capacity of tank venting devices 12 inches and smaller in nominal pipe size shall be determined by actual test of each type and size of vent. These flow tests may be conducted by the manufacturer if certified by a qualified impartial observer, or may be conducted by an outside agency. The flow capacity of tank venting devices larger than 12 inches nominal pipe size, including manhole covers with long bolts or equivalent, may be calculated provided that the opening pressure is actually measured, the rating pressure and corresponding free orifice area are stated, the word "calculated" appears on the nameplate, and the computation is based on a flow coefficient of 0.5 applied to the rated orifice area.

(vi) *Vent piping for aboveground tanks.* (a) Vent piping shall be constructed in accordance with paragraph (c) of this section.

(b) Where vent pipe outlets for tanks storing Class I liquids are adjacent to buildings or public ways, they shall be located so that the vapors are released at a safe point outside of buildings and not less than 12 feet above the adjacent ground level. In order to aid their dispersion, vapors shall be discharged upward or horizontally away from closely adjacent walls. Vent outlets shall be located so that flammable vapors will not be trapped by eaves or other obstructions and shall be at least five feet from building openings.

(c) When tank vent piping is manifolded, pipe sizes shall be such as to discharge, within the pressure limitations of the system, the vapors they may be required to handle when manifolded tanks are subject to the same fire exposure.

(vii) *Drainage, dikes, and walls for aboveground tanks—(a) Drainage and diked areas.* The area surrounding a tank or a group of tanks shall be provided with drainage as in subdivision (b) of this subdivision, or shall be diked as provided in subdivision (c) of this subdivision, to prevent accidental discharge of liquid from endangering adjoining property or reaching waterways.

(b) *Drainage.* Where protection of adjoining property or waterways is by means of a natural or manmade drainage system, such systems shall comply with the following:

(1) A slope of not less than 1 percent away from the tank toward the drainage system shall be provided.

(2) The drainage system shall terminate in vacant land or other area or in an impounding basin having a capacity not smaller than that of the largest tank served. This termination area and the route of the drainage system shall be so located that, if the flammable or combustible liquids in the drainage system are ignited, the fire will not seriously expose tanks or adjoining property.

(3) The drainage system, including automatic drainage pumps, shall not discharge to adjoining property, natural water courses, public sewers, or public drains unless the discharge of flammable or combustible liquids would not constitute a hazard, or the system is so designed that it will not permit flammable or combustible liquids to be released.

(c) *Diked areas.* Where protection of adjoining property or waterways is accomplished by retaining the liquid around the tank by means of a dike, the volume of the diked area shall comply with the following requirements:

(1) Except as provided in subdivision (2) of this subdivision, the volumetric capacity of the diked area shall not be less than the greatest amount of liquid that can be released from the largest tank within the diked area, assuming a full tank. The capacity of the diked area enclosing more than one tank shall be calculated by deducting the volume of the tanks other than the largest tank below the height of the dike.

(2) For a tank or group of tanks with fixed roofs containing crude petroleum with boilover characteristics, the volumetric capacity of the diked area shall be not less than the capacity of the largest tank served by the enclosure, assuming a full tank. The capacity of the diked enclosure shall be calculated by deducting the volume below the height of the dike of all tanks within the enclosure.

(3) Walls of the diked area shall be of earth, steel, concrete or solid masonry designed to be liquidtight and to withstand a full hydrostatic head. Earthen walls 3 feet or more in height shall have a flat section at the top not less than 2 feet wide. The slope of an earthen wall shall be consistent with the angle of repose of the material of which the wall is constructed.

(4) The walls of the diked area shall be restricted to an average height of 6 feet above interior grade.

(5) Where provision is made for draining water from diked areas, drainage shall be provided at a uniform slope of not less than 1 percent away from tanks toward a sump, drainbox, or other safe means of disposal located at the greatest practical distance from the tank. Such drains shall normally be controlled in a manner so as to prevent flammable or combustible liquids from entering natural water courses, public sewers, or public drains, if their presence would constitute a hazard. Control of drainage shall be accessible under fire conditions.

(6) No loose combustible material, empty or full drum or barrel, shall be permitted within the diked area.

(7) Each diked area containing two or more tanks shall be subdivided preferably by drainage channels or at least by intermediate curbs in order to prevent spills from endangering adjacent tanks within the diked area as follows:

(i) When storing normally stable liquids in vertical cone roof tanks constructed with weak roof-to-shell seam or approved floating roof tanks or when storing crude petroleum in producing areas in any type of tank, one subdivision for each tank in excess of 10,000 bbls. and one subdivision for each group of tanks (no tank exceeding 10,000 bbls. capacity) having an aggregate capacity not exceeding 15,000 bbls.

(ii) When storing normally stable flammable or combustible liquids in tanks not covered in subdivision (i) of this subdivision, one subdivision for each tank in excess of 100,000 gallons (2,500 bbls.) and one subdivision for each group of tanks (no tank exceeding 100,000 gallons capacity) having an aggregate capacity not exceeding 150,000 gallons (3,570 bbls.).

(iii) When storing unstable liquids in any type of tank, one subdivision for each tank except that tanks installed in accordance with the drainage requirements of NFPA 15-1969, Standard for Water Spray Fixed Systems for Fire Protection shall require no additional subdivision.

(iv) The drainage channels or intermediate curbs shall be located between tanks so as to take full advantage of the available space with due regard for the individual tank capacities. Intermediate curbs, where used, shall be not less than 18 inches in height.

(viii) *Tank openings other than vents for aboveground tanks.* (a) Connections for all tank openings shall be vaportight and liquidtight. Vents are covered in subdivisions (iv) through (vi) of this subparagraph.

(b) Each connection to an aboveground tank through which liquid can normally flow shall be provided with an internal or an external valve located as close as practical to the shell of

the tank. Such valves, when external, and their connections to the tank shall be of steel except when the chemical characteristics of the liquid stored are incompatible with steel. When materials other than steel are necessary, they shall be suitable for the pressures, structural stresses, and temperatures involved, including fire exposures.

(c) Each connection below the liquid level through which liquid does not normally flow shall be provided with a liquidtight closure. This may be a valve, plug, or blind, or a combination of these.

(d) Openings for gaging shall be provided with a vaportight cap or cover.

(e) For Class IB and Class IC liquids other than crude oils, gasolines, and asphalts, the fill pipe shall be so designed and installed as to minimize the possibility of generating static electricity. A fill pipe entering the top of a tank shall terminate within 6 inches of the bottom of the tank and shall be installed to avoid excessive vibration.

(f) Filling and emptying connections which are made and broken shall be located outside of buildings at a location free from any source of ignition and not less than 5 feet away from any building opening. Such connection shall be closed and liquidtight when not in use. The connection shall be properly identified.

(3) *Installation of underground tanks*—(i) *Location.* Excavation for underground storage tanks shall be made with due care to avoid undermining of foundations of existing structures. Underground tanks or tanks under buildings shall be so located with respect to existing building foundations and supports that the loads carried by the latter cannot be transmitted to the tank. The distance from any part of a tank storing Class I liquids to the nearest wall of any basement or pit shall be not less than 1 foot, and to any property line that may be built upon, not less than 3 feet. The distance from any part of a tank storing Class II or Class III liquids to the nearest wall of any basement, pit or property line shall be not less than 1 foot.

(ii) *Depth and cover.* Underground tanks shall be set on firm foundations and surrounded with at least 6 inches of noncorrosive, inert materials such as clean sand, earth, or gravel well tamped in place. The tank shall be placed in the hole with care since dropping or rolling the tank into the hole can break a weld, puncture or damage the tank, or scrape off the protective coating of coated tanks. Tanks shall be covered with a minimum of 2 feet of earth, or shall be covered with not less than 1 foot of earth, on top of which shall be placed a slab of reinforced concrete not less than 4 inches thick. When underground tanks are, or are likely to be, subject to traffic, they shall be protected against damage from vehicles passing over them by at least 3 feet of earth cover, or 18 inches of well-tamped earth, plus 6 inches of reinforced concrete or 8 inches of asphaltic concrete. When asphaltic or reinforced concrete paving is used as part of the protection, it shall extend at least 1 foot horizontally beyond the outline of the tank in all directions.

(iii) *Corrosion protection.* Corrosion protection for the tank and its piping shall be provided by one or more of the following methods:

(a) Use of protective coatings or wrappings;

(b) Cathodic protection; or,

(c) Corrosion resistant materials of construction.

(iv) *Vents.* (a) Location and arrangement of vents for Class I liquids. Vent pipes from tanks storing Class I liquids shall be so located that the discharge point is outside of buildings, higher than the fill pipe opening, and not less than 12 feet above the adjacent ground level. Vent pipes shall discharge only upward in order to disperse vapors. Vent pipes 2 inches or less in nominal inside diameter shall not be obstructed by devices that will cause excessive back pressure. Vent pipe outlets shall be so located that flammable vapors will not enter building openings, or be trapped under eaves or other obstructions. If the vent pipe is less than 10 feet in length, or greater than 2 inches in nominal inside diameter, the outlet shall be provided with a vacuum and pressure relief device or there shall be an approved flame arrester located in the vent line at the outlet or within the approved distance from the outlet.

(b) Size of vents. Each tank shall be vented through piping adequate in size to prevent blow-back of vapor or liquid at the fill opening while the tank is being filled. Vent pipes shall be not less than 1¼ inch nominal inside diameter.

TABLE H-11—VENT LINE DIAMETERS

| Maximum flow GPM | Pipe length* | | |
|---|---|---|---|
| | 50 feet | 100 feet | 200 feet |
| | *Inches* | *Inches* | *Inches* |
| 100 | 1¼ | 1¼ | 1¼ |
| 200 | 1¼ | 1¼ | 1¼ |
| 300 | 1¼ | 1¼ | 1½ |
| 400 | 1¼ | 1½ | 2 |
| 500 | 1½ | 1½ | 2 |
| 600 | 1½ | 2 | 2 |
| 700 | 2 | 2 | 2 |
| 800 | 2 | 2 | 3 |
| 900 | 2 | 2 | 3 |
| 1,000 | 2 | 2 | 3 |

*Vent lines of 50 ft., 100 ft., and 200 ft. of pipe plus 7 ells.

(c) Location and arrangement of vents for Class II or Class III liquids. Vent pipes from tanks storing Class II or Class III flammable liquids shall terminate outside of the building and higher than the fill pipe opening. Vent outlets shall be above normal snow level. They may be fitted with return bends, coarse screens or other devices to minimize ingress of foreign material.

(d) Vent piping shall be constructed in accordance with paragraph (c) of this section. Vent pipes shall be so laid as to drain toward the tank without sags or traps in which liquid can collect. They shall be located so that they will not be subjected to physical damage. The tank end of the vent pipe shall enter the tank through the top.

(e) When tank vent piping is manifolded, pipe sizes shall be such as to discharge, within the pressure limitations of the system, the vapors they may be required to handle when manifolded tanks are filled simultaneously.

(v) *Tank openings other than vents.* (a) Connections for all tank openings shall be vapor or liquid tight.

(b) Openings for manual gaging, if independent of the fill pipe, shall be provided with a liquid-tight cap or cover. If inside a building, each such opening shall be protected against liquid overflow and possible vapor release by means of a spring loaded check valve or other approved device.

(c) Fill and discharge lines shall enter tanks only through the top. Fill lines shall be sloped toward the tank.

(d) For Class IB and Class IC liquids other than crude oils, gasolines, and asphalts, the fill pipe shall be so designed and installed as to minimize the possibility of generating static electricity by terminating within 6 inches of the bottom of the tank.

(e) Filling and emptying connections which are made and broken shall be located outside of buildings at a location free from any source of ignition and not less than 5 feet away from any building opening. Such connection shall be closed and liquidtight when not in use. The connection shall be properly identified.

(4) *Installation of tanks inside of buildings*—(i) *Location.* Tanks shall not be permitted inside of buildings except as provided in paragraphs (e), (g), (h), or (i) of this section.

(ii) *Vents.* Vents for tanks inside of buildings shall be as provided in subparagraphs (2)(iv), (v), (vi)(b), and (3)(iv) of this paragraph, except that emergency venting by the use of weak roof seams on tanks shall not be permitted. Vents shall discharge vapors outside the buildings.

(iii) *Vent piping.* Vent piping shall be constructed in accordance with paragraph (c) of this section.

(iv) *Tank openings other than vents.* (*a*) Connections for all tank openings shall be vapor or liquidtight. Vents are covered in subdivision (ii) of this subparagraph.

(*b*) Each connection to a tank inside of buildings through which liquid can normally flow shall be provided with an internal or an external valve located as close as practical to the shell of the tank. Such valves, when external, and their connections to the tank shall be of steel except when the chemical characteristics of the liquid stored are incompatible with steel. When materials other than steel are necessary, they shall be suitable for the pressures, structural stresses, and temperatures involved, including fire exposures.

(*c*) Flammable or combustible liquid tanks located inside of buildings, except in one-story buildings designed and protected for flammable or combustible liquid storage, shall be provided with an automatic-closing heat-actuated valve on each withdrawal connection below the liquid level, except for connections used for emergency disposal, to prevent continued flow in the event of fire in the vicinity of the tank. This function may be incorporated in the valve required in (*b*) of this subdivision, and if a separate valve, shall be located adjacent to the valve required in (*b*) of this subdivision.

(*d*) Openings for manual gaging, if independent of the fill pipe (see (*f*) of this subdivision), shall be provided with a vaportight cap or cover. Each such opening shall be protected against liquid overflow and possible vapor release by means of a spring loaded check valve or other approved device.

(*e*) For Class IB and Class IC liquids other than crude oils, gasolines, and asphalts, the fill pipe shall be so designed and installed as to minimize the possibility of generating static electricity by terminating within 6 inches of the bottom of the tank.

(*f*) The fill pipe inside of the tank shall be installed to avoid excessive vibration of the pipe.

(*g*) The inlet of the fill pipe shall be located outside of buildings at a location free from any source of ignition and not less than 5 feet away from any building opening. The inlet of the fill pipe shall be closed and liquidtight when not in use. The fill connection shall be properly identified.

(*h*) Tanks inside buildings shall be equipped with a device, or other means shall be provided, to prevent overflow into the building.

(5) *Supports, foundations, and anchorage for all tank locations*—(i) *General.* Tank supports shall be installed on firm foundations. Tank supports shall be of concrete, masonry, or protected steel. Single wood timber supports (not cribbing) laid horizontally may be used for outside aboveground tanks if not more than 12 inches high at their lowest point.

(ii) *Fire resistance.* Steel supports or exposed piling shall be protected by materials having a fire resistance rating of not less than 2 hours, except that steel saddles need not be protected if less than 12 inches high at their lowest point. Water spray protection or its equivalent may be used in lieu of fire-resistive materials to protect supports.

(iii) *Spheres.* The design of the supporting structure for tanks such as spheres shall receive special engineering consideration.

(iv) *Load distribution.* Every tank shall be so supported as to prevent the excessive concentration of loads on the supporting portion of the shell.

(v) *Foundations.* Tanks shall rest on the ground or on foundations made of concrete, masonry, piling, or steel. Tank foundations shall be designed to minimize the possibility of uneven settling of the tank and to minimize corrosion in any part of the tank resting on the foundation.

(vi) *Flood areas.* Where a tank is located in an area that may be subjected to flooding, the applicable precautions outlined in this subdivision shall be observed.

(*a*) No aboveground vertical storage tank containing a flammable or combustible liquid shall be located so that the allowable liquid level within the tank is below the established maximum flood stage, unless the tank is provided with a guiding structure such as described in (*m*), (*n*), and (*o*) of this subdivision.

(*b*) Independent water supply facilities shall be provided at locations where there is no ample and dependable public water supply available for loading partially empty tanks with water.

(*c*) In addition to the preceding requirements, each tank so located that more than 70 percent, but less than 100 percent, of its allowable liquid storage capacity will be submerged at the established maximum flood stage, shall be safeguarded by one of the following methods: Tank shall be raised, or its height shall be increased, until its top extends above the maximum flood stage a distance equivalent to 30 percent or more of its allowable liquid storage capacity: *Provided, however,* That the submerged part of the tank shall not exceed two and one-half times the diameter. Or, as an alternative to the foregoing, adequate noncombustible structural guides, designed to permit the tank to float vertically without loss of product, shall be provided.

(*d*) Each horizontal tank so located that more than 70 percent of its storage capacity will be submerged at the established flood stage, shall be anchored, attached to a foundation of concrete or of steel and concrete, of sufficient weight to provide adequate load for the tank when filled with flammable or combustible liquid and submerged by flood waters to the established flood stage, or adequately secured by other means.

(*e*) Spherical and spheroidal tanks shall be protected by applicable methods as specified for either vertical or horizontal tanks.

(*f*) At locations where there is no ample and dependable water supply, or where filling of underground tanks with liquids is impracticable because of the character of their contents, their use, or for other reasons, each tank shall be safeguarded against movement when empty and submerged by high ground water or flood waters by anchoring, weighting with concrete or other approved solid loading material, or securing by other means. Each such tank shall be so constructed and installed that it will safely resist external pressures due to high ground water or flood waters.

(*g*) At locations where there is an ample and dependable water supply available, underground tanks containing flammable or combustible liquids, so installed that more than 70 percent of their storage capacity will be submerged at the maximum flood stage, shall be so anchored, weighted, or secured by other means, as to prevent movement of such tanks when filled with flammable or combustible liquids, and submerged by flood waters to the established flood stage.

(*h*) Pipe connections below the allowable liquid level in a tank shall be provided with valves or cocks located as closely as practicable to the tank shell. Such valves and their connections to tanks shall be of steel or other material suitable for use with the liquid being stored. Cast iron shall not be permitted.

(*i*) At locations where an independent water supply is required, it shall be entirely independent of public power and water supply. Independent source of water shall be available when flood waters reach a level not less than 10 feet below the bottom of the lowest tank on a property.

(*j*) The self-contained power and pumping unit shall be so located or so designed that pumping into tanks may be carried on continuously throughout the rise in flood waters from a level 10 feet below the lowest tank to the level of the potential flood stage.

(*k*) Capacity of the pumping unit shall be such that the rate of rise of

water in all tanks shall be equivalent to the established potential average rate of rise of flood waters at any stage.

(*l*) Each independent pumping unit shall be tested periodically to insure that it is in satisfactory operating condition.

(*m*) Structural guides for holding floating tanks above their foundations shall be so designed that there will be no resistance to the free rise of a tank, and shall be constructed of noncombustible material.

(*n*) The strength of the structure shall be adequate to resist lateral movement of a tank subject to a horizontal force in any direction equivalent to not less than 25 pounds per square foot acting on the projected vertical cross-sectional area of the tank.

(*o*) Where tanks are situated on exposed points or bends in a shoreline where swift currents in flood waters will be present, the structures shall be designed to withstand a unit force of not less than 50 pounds per square foot.

(*p*) The filling of a tank to be protected by water loading shall be started as soon as flood waters reach a dangerous flood stage. The rate of filling shall be at least equal to the rate of rise of the floodwaters (or the established average potential rate of rise).

(*q*) Sufficient fuel to operate the water pumps shall be available at all times to insure adequate power to fill all tankage with water.

(*r*) All valves on connecting pipelines shall be closed and locked in closed position when water loading has been completed.

(*s*) Where structural guides are provided for the protection of floating tanks, all rigid connections between tanks and pipelines shall be disconnected and blanked off or blinded before the floodwaters reach the bottom of the tank, unless control valves and their connections to the tank are of a type designed to prevent breakage between the valve and the tank shell.

(*t*) All valves attached to tanks other than those used in connection with water loading operations shall be closed and locked.

(*u*) If a tank is equipped with a swing line, the swing pipe shall be raised to and secured at its highest position.

(*v*) Inspections. The Assistant Secretary or his designated representative shall make periodic inspections of all plants where the storage of flammable or combustible liquids is such as to require compliance with the foregoing requirements, in order to assure the following:

(*1*) That all flammable or combustible liquid storage tanks are in compliance with these requirements and so maintained.

(*2*) That detailed printed instructions of what to do in flood emergencies are properly posted.

(*3*) That station operators and other employees depended upon to carry out such instructions are thoroughly informed as to the location and operation of such valves and other equipment necessary to effect these requirements.

(vii) *Earthquake areas.* In areas subject to earthquakes, the tank supports and connections shall be designed to resist damage as a result of such shocks.

(6) *Sources of ignition.* In locations where flammable vapors may be present, precautions shall be taken to prevent ignition by eliminating or controlling sources of ignition. Sources of ignition may include open flames, lightning, smoking, cutting and welding, hot surfaces, frictional heat, sparks (static, electrical, and mechanical), spontaneous ignition, chemical and physical-chemical reactions, and radiant heat.

(7) *Testing*—(i) *General.* All tanks, whether shop built or field erected, shall be strength tested before they are placed in service in accordance with the applicable paragraphs of the code under which they were built. The American Society of Mechanical Engineers (ASME) code stamp, American Petroleum Institute (API) monogram, or the label of the Underwriters' Laboratories, Inc., on a tank shall be evidence of compliance with this strength test. Tanks not marked in accordance with the above codes shall be strength tested before they are placed in service in accordance with good engineering principles and reference shall be made to the sections on testing in the codes listed in subparagraphs (1) (iii) (*a*), (iv) (*b*), or (v) (*b*) of this paragraph.

(ii) *Strength.* When the vertical length of the fill and vent pipes is such that when filled with liquid the static head imposed upon the bottom of the tank exceeds 10 pounds per square inch, the tank and related piping shall be tested hydrostatically to a pressure equal to the static head thus imposed.

(iii) *Tightness.* In addition to the strength test called for in subdivisions (i) and (ii) of this subparagraph, all tanks and connections shall be tested for tightness. Except for underground tanks, this tightness test shall be made at operating pressure with air, inert gas, or water prior to placing the tank in service. In the case of field-erected tanks the strength test may be considered to be the test for tank tightness. Underground tanks and piping, before being covered, enclosed, or placed in use, shall be tested for tightness hydrostatically, or with air pressure at not less than 3 pounds per square inch and not more than 5 pounds per square inch.

(iv) *Repairs.* All leaks or deformations shall be corrected in an acceptable manner before the tank is placed in service. Mechanical caulking is not permitted for correcting leaks in welded tanks except pinhole leaks in the roof.

(v) *Derated operations.* Tanks to be operated at pressures below their design pressure may be tested by the applicable provisions of subdivisions (i) or (ii) of this subparagraph, based upon the pressure developed under full emergency venting of the tank.

(c) *Piping, valves, and fittings*—(1) *General*—(i) *Design.* The design (including selection of materials) fabrication, assembly, test, and inspection of piping systems containing flammable or combustible liquids shall be suitable for the expected working pressures and structural stresses. Conformity with the applicable provisions of Pressure Piping, ANSI B31 series and the provisions of this paragraph, shall be considered prima facie evidence of compliance with the foregoing provisions.

(ii) *Exceptions.* This paragraph does not apply to any of the following:

(*a*) Tubing or casing on any oil or gas wells and any piping connected directly thereto.

(*b*) Motor vehicle, aircraft, boat, or portable or stationary engines.

(*c*) Piping within the scope of any applicable boiler and pressures vessel code.

(iii) *Definitions.* As used in this paragraph, piping systems consist of pipe, tubing, flanges, bolting, gaskets, valves, fittings, the pressure containing parts of other components such as expansion joints and strainers, and devices which serve such purposes as mixing, separating, snubbing, distributing, metering, or controlling flow.

(2) *Materials for piping, valves, and fittings*—(i) *Required materials.* Materials for piping, valves, or fittings shall be steel, nodular iron, or malleable iron, except as provided in paragraph (c) (2) (ii), (iii) and (iv) of this section.

(ii) *Exceptions.* Materials other than steel, nodular iron, or malleable iron may be used underground, or if required by the properties of the flammable or combustible liquid handled. Material other than steel, nodular iron, or malleable iron shall be designed to specifications embodying principles recognized as good engineering practices for the material used.

(iii) *Linings.* Piping, valves, and fittings may have combustible or noncombustible linings.

(iv) *Low-melting materials.* When low-melting point materials such as aluminum and brass or materials that soften on fire exposure such as plas-

tics, or nonductile materials such as cast iron, are necessary, special consideration shall be given to their behavior on fire exposure. If such materials are used in above ground piping systems or inside buildings, they shall be suitably protected against fire exposure or so located that any spill resulting from the failure of these materials could not unduly expose persons, important buildings or structures or can be readily controlled by remote valves.

(3) *Pipe joints.* Joints shall be made liquid tight. Welded or screwed joints or approved connectors shall be used. Threaded joints and connections shall be made up tight with a suitable lubricant or piping compound. Pipe joints dependent upon the friction characteristics of combustible materials for mechanical continuity of piping shall not be used inside buildings. They may be used outside of buildings above or below ground. If used above ground, the piping shall either be secured to prevent disengagement at the fitting or the piping system shall be so designed that any spill resulting from such disengagement could not unduly expose persons, important buildings or structures, and could be readily controlled by remote valves.

(4) *Supports.* Piping systems shall be substantially supported and protected against physical damage and excessive stresses arising from settlement, vibration, expansion, or contraction.

(5) *Protection against corrosion.* All piping for flammable or combustible liquids, both aboveground and underground, where subject to external corrosion, shall be painted or otherwise protected.

(6) *Valves.* Piping systems shall contain a sufficient number of valves to operate the system properly and to protect the plant. Piping systems in connection with pumps shall contain a sufficient number of valves to control properly the flow of liquid in normal operation and in the event of physical damage. Each connection to pipelines, by which equipments such as tankcars or tank vehicles discharge liquids by means of pumps into storage tanks, shall be provided with a check valve for automatic protection against backflow if the piping arrangement is such that backflow from the system is possible.

(7) *Testing.* All piping before being covered, enclosed, or placed in use shall be hydrostatically tested to 150 percent of the maximum anticipated pressure of the system, or pneumatically tested to 110 percent of the maximum anticipated pressure of the system, but not less than 5 pounds per square inch gage at the highest point of the system. This test shall be maintained for a sufficient time to complete visual inspection of all joints and connections, but for at least 10 minutes.

**§ 1910.110 Storage and handling of liquefied petroleum gases.**

* * * * *

(b) *Basic rules*—(1) *Odorizing gases.* (i) All liquefied petroleum gases shall be effectively odorized by an approved agent of such character as to indicate positively, by distinct odor, the presence of gas down to concentration in air of not over one-fifth the lower limit of flammability. Odorization, however, is not required if harmful in the use of further processing of the liquefied petroleum gas, or if odorization will serve no useful purpose as a warning agent in such use or further processing.

(ii) The odorization requirement of subdivision (i) of this subparagraph shall be considered to be met by the use of 1.0 pounds of ethyl mercaptan, 1.0 pounds of thiophane or 1.4 pounds of amyl mercaptan per 10,000 gallons of LP-Gas. However, this listing of odorants and quantities shall not exclude the use of other odorants that meet the odorization requirements of subdivision (i) of this subparagraph.

(2) *Approval of equipment and systems.* (i) Each system utilizing DOT containers in accordance with 49 CFR Part 178 shall have its container valves, connectors, manifold valve assemblies, and regulators approved.

(ii) Each system for domestic or commercial use utilizing containers of 2,000 gallons or less water capacity, other than those constructed in accordance with 49 CFR Part 178, shall consist of a container assembly and one or more regulators, and may include other parts. The system as a unit or the container assembly as a unit, and the regulator or regulators, shall be individually listed.

(iii) In systems utilizing containers of over 2,000 gallons water capacity, each regulator, container valve, excess flow valve, gaging device, and relief valve installed on or at the container, shall have its correctness as to design, construction, and performance determined by listing by Underwriters' Laboratories, Inc., or Factory Mutual Engineering Corp.

(3) *Requirements for construction and original test of containers.* (i) Containers used with systems embodied in paragraphs (d), (e), (g), and (h) of this section, except as provided in paragraphs (e)(3)(iii) and (g)(2)(i) of this section, shall be designed, constructed, and tested in accordance with the Rules for Construction of Unfired Pressure Vessels, section VIII, Division 1, American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, 1968 edition.

(ii) Containers constructed according to the 1949 and earlier editions of the ASME Code do not have to comply with paragraphs U-2 through U-10 and U-19 thereof. Containers constructed according to paragraph U-70 in the 1949 and earlier editions are not authorized.

(iii) Containers designed, constructed, and tested prior to July 1, 1961, according to the Code for Unfired Pressure Vessels for Petroleum Liquids and Gases, 1951 edition with 1954 Addenda, of the American Petroleum Institute and the American Society of Mechanical Engineers shall be considered in conformance. Containers constructed according to API-ASME Code do not have to comply with section I or with appendix to section I. Paragraphs W-601 to W-606 inclusive in the 1943 and earlier editions do not apply.

(iv) The provisions of subdivision (i) of this subparagraph shall not be construed as prohibiting the continued use or reinstallation of containers constructed and maintained in accordance with the standard for the Storage and Handling of Liquefied Petroleum Gases NFPA No. 58 in effect at the time of fabrication.

(v) Containers used with systems embodied in paragraph (b), (d)(3)(iii), and (f) of this section, shall be constructed, tested, and stamped in accordance with DOT specifications effective at the date of their manufacture.

(4) *Welding of containers.* (i) Welding to the shell, head, or any other part of the container subject to internal pressure, shall be done in compliance with the code under which the tank was fabricated. Other welding is permitted only on saddle plates, lugs, or brackets attached to the container by the tank manufacturer.

(ii) Where repair or modification involving welding of DOT containers is required, the container shall be returned to a qualified manufacturer making containers of the same type, and the repair or modification made in compliance with DOT regulations.

(5) *Markings on containers.* (i) Each container covered in subparagraph (3)(i) of this paragraph, except as provided in subparagraph (3)(iv) of this paragraph shall be marked as specified in the following:

(*a*) With a marking identifying compliance with, and other markings required by, the rules of the reference under which the container is constructed; or with the stamp and other markings required by the National Board of Boiler and Pressure Vessel Inspectors.

(*b*) With notation as to whether the container is designed for underground or aboveground installation or both. If intended for both and different style hoods are provided, the marking shall

indicate the proper hood for each type of installation.

(c) With the name and address of the supplier of the container, or with the trade name of the container.

(d) With the water capacity of the container in pounds or gallons, U.S. Standard.

(e) With the pressure in p.s.i.g., for which the container is designed.

(f) With the wording "This container shall not contain a product having a vapor pressure in excess of — p.s.i.g. at 100° F.," see subparagraph (14)(viii) of this paragraph.

(g) With the tare weight in pounds or other identified unit of weight for containers with a water capacity of 300 pounds or less.

(h) With marking indicating the maximum level to which the container may be filled with liquid at temperatures between 20° F. and 130° F., except on containers provided with fixed maximum level indicators or which are filled by weighing. Markings shall be increments of not more than 20° F. This marking may be located on the liquid level gaging device.

(i) With the outside surface area in square feet.

(ii) Markings specified shall be on a metal nameplate attached to the container and located in such a manner as to remain visible after the container is installed.

(iii) When LP-Gas and one or more other gases are stored or used in the same area, the containers shall be marked to identify their content. Marking shall be in compliance with American National Standard Z48.1-1954, "Method of Marking Portable Compressed Gas Containers To Identify the Material Contained."

(6) *Location of containers and regulating equipment.* (i) Containers, and first stage regulating equipment if used, shall be located outside of buildings, except under one or more of the following:

(a) In buildings used exclusively for container charging, vaporization pressure reduction, gas mixing, gas manufacturing, or distribution.

(b) When portable use is necessary and in accordance with paragraph (c)(5) of this section.

(c) LP-Gas fueled stationary or portable engines in accordance with paragraph (e) (11) or (12) of this section.

(d) LP-Gas fueled industrial trucks used in accordance with paragraph (e)(13) of this section.

(e) LP-Gas fueled vehicles garaged in accordance with paragraph (e)(14) of this section.

(f) Containers awaiting use or resale when stored in accordance with paragraph (f) of this section.

(ii) Each individual container shall be located with respect to the nearest important building or group of buildings or line of adjoining property which may be built in accordance with Table H-23.

TABLE H-23

| Water capacity per container | Minimum distances: Containers: Underground | Minimum distances: Containers: Aboveground | Minimum distances: Between aboveground containers |
|---|---|---|---|
| Less than 125 gals.[1] | 10 feet | None | None. |
| 125 to 250 gals | 10 feet | 10 feet | None. |
| 251 to 500 gals | 10 feet | 10 feet | 3 feet. |
| 501 to 2,000 gals | 25 feet[2] | 25 feet[2] | 3 feet. |
| 2,001 to 30,000 gals. | 50 feet | 50 feet | 5 feet. |
| 30,001 to 70,000 gals. | 50 feet | 75 feet | ¼ of sum of diameters of adjacent containers. |
| 70,001 to 90,000 gals. | 50 feet | 100 feet | ¼ of sum of diameters of adjacent containers. |

[1] If the aggregate water capacity of a multi-container installation at a consumer site is 501 gallons or greater, the minimum distance shall comply with the appropriate portion of this table, applying the aggregate capacity rather than the capacity per container. If more than one installation is made, each installation shall be separated from another installation by at least 25 feet. Do not apply the MINIMUM DISTANCES BETWEEN ABOVEGROUND CONTAINERS to such installations.

[2] NOTE: The above distance requirements may be reduced to not less than 10 feet for a single container of 1,200 gallons water capacity or less, providing such a container is at least 25 feet from any other LP-Gas container of more than 125 gallons water capacity.

(iii) Containers installed for use shall not be stacked one above the other.

(iv) In industrial installations involving containers of 180,000 gallons aggregate water capacity or more, where serious mutual exposures between the container and adjacent properties prevail, firewalls or other means of special protection designed and constructed in accordance with good engineering practices are required.

(v) In the case of buildings devoted exclusively to gas manufacturing and distributing operations, the distances required by Table H-23 may be reduced provided that in no case shall containers of water capacity exceeding 500 gallons be located closer than 10 feet to such gas manufacturing and distributing buildings.

(vi) Readily ignitible material such as weeds and long dry grass shall be removed within 10 feet of any container.

(vii) The minimum separation between liquefied petroleum gas containers and flammable liquid tanks shall be 20 feet, and the minimum separation between a container and the centerline of the dike shall be 10 feet. The foregoing provision shall not apply when LP-Gas containers of 125 gallons or less capacity are installed adjacent to Class III flammable liquid tanks of 275 gallons or less capacity.

(viii) Suitable means shall be taken to prevent the accumulation of flammable liquids under adjacent liquified petroleum gas containers, such as by diking, diversion curbs, or grading.

(ix) When dikes are used with flammable liquid tanks, no liquefied petroleum gas containers shall be located within the diked area.

(7) *Container valves and container accessories.* (i) Valves, fittings, and accessories connected directly to the container including primary shutoff valves, shall have a rated working pressure of at least 250 p.s.i.g. and shall be of material and design suitable for LP-Gas service. Cast iron shall not be used for container valves, fittings, and accessories. This does not prohibit the use of container valves made of malleable or nodular iron.

(ii) Connections to containers, except safety relief connections, liquid level gaging devices, and plugged openings, shall have shutoff valves located as close to the container as practicable.

(iii) Excess flow valves, where required shall close automatically at the rated flows of vapor or liquid as specified by the manufacturer. The connections or line including valves, fittings, etc., being protected by an excess flow valve shall have a greater capacity than the rated flow of the excess flow valve.

(iv) Liquid level gaging devices which are so constructed that outward flow of container contents shall not exceed that passed by a No. 54 drill size opening, need not be equipped with excess flow valves.

(v) Openings from container or through fittings attached directly on container to which pressure gage connection is made, need not be equipped with shutoff or excess flow valves if such openings are restricted to not larger than No. 54 drill size opening.

(vi) Except as provided in paragraph (c)(5)(i)(b) of this section, excess flow and back pressure check valves where required by this section shall be located inside of the container or at a point outside where the line enters the container; in the latter case, installation shall be made in such manner that any undue strain beyond the excess flow or back pressure check valve will not cause breakage between the container and such valve.

(vii) Excess flow valves shall be designed with a bypass, not to exceed a No. 60 drill size opening to allow equalization of pressures.

(viii) Containers of more than 30 gallons water capacity and less than 2,000 gallons water capacity, filled on a volumetric basis, and manufactured after

December 1, 1963, shall be equipped for filling into the vapor space.

(8) *Piping—including pipe, tubing, and fittings.* (i) Pipe, except as provided in paragraphs (e)(6)(i) and (g)(10)(iii), of this section shall be wrought iron or steel (black or galvanized), brass, copper, or aluminum alloy. Aluminum alloy pipe shall be at least Schedule 40 in accordance with the specifications for Aluminum Alloy Pipe, American National Standards Institute (ANSI) H38.-7-1969 (ASTM, B241-69), except that the use of alloy 5456 is prohibited and shall be suitably marked at each end of each length indicating compliance with American National Standards Institute Specifications. Aluminum Alloy pipe shall be protected against external corrosion when it is in contact with dissimilar metals other than galvanized steel, or its location is subject to repeated wetting by such liquids as water (except rain water), detergents, sewage, or leaking from other piping, or it passes through flooring, plaster, masonry, or insulation. Galvanized sheet steel or pipe, galvanized inside and out, may be considered suitable protection. The maximum nominal pipe size for aluminum pipe shall be three-fourths inch and shall not be used for pressures exceeding 20 p.s.i.g. Aluminum alloy pipe shall not be installed within 6 inches of the ground.

(*a*) Vapor piping with operating pressures not exceeding 125 p.s.i.g. shall be suitable for a working pressure of at least 125 p.s.i.g. Pipe shall be at least Schedule 40 (ASTM A-53-69, Grade B Electric Resistance Welded and Electric Flash Welded Pipe or equal).

(*b*) Vapor piping with operating pressures over 125 p.s.i.g. and all liquid piping shall be suitable for a working pressure of at least 250 p.s.i.g. Pipe shall be at least Schedule 80 if joints are threaded or threaded and back welded. At least Schedule 40 (ASTM A-53-69 Grade B Electric Resistance Welded and Electric Flash Welded Pipe or equal) shall be used if joints are welded, or welded and flanged.

(ii) Tubing shall be seamless and of copper, brass, steel, or aluminum alloy. Copper tubing shall be of type K or L or equivalent as covered in the Specification for Seamless Copper Water Tube, ANSI H23.1-1970 (ASTM B88-69). Aluminum alloy tubing shall be of Type A or B or equivalent as covered in Specification ASTM B210-68 and shall be suitably marked every 18 inches indicating compliance with ASTM Specifications. The minimum nominal wall thickness of copper tubing and aluminum alloy tubing shall be as specified in Table H-24 and Table H-25.

TABLE H-24—WALL THICKNESS OF COPPER TUBING [1]

NOTE: The standard size by which tube is designated is ⅛-inch smaller than its nominal outside diameter.

| Standard size (inches) | Nominal O.D. (inches) | Nominal wall thickness (inches) | |
|---|---|---|---|
| | | Type K | Type L |
| ¼ | 0.375 | 0.035 | 0.030 |
| ⅜ | 0.500 | 0.049 | 0.035 |
| ½ | 0.625 | 0.049 | 0.040 |
| ⅝ | 0.750 | 0.049 | 0.042 |
| ¾ | 0.875 | 0.065 | 0.045 |
| 1 | 1.125 | 0.065 | 0.050 |
| 1¼ | 1.375 | 0.065 | 0.055 |
| 1½ | 1.625 | 0.072 | 0.060 |
| 2 | 2.125 | 0.083 | 0.070 |

[1] Based on data in Specification for Seamless Copper Water Tube, ANSI H23.1-1970 (ASTM B-88-69).

TABLE H-25—WALL THICKNESS OF ALUMINUM ALLOY TUBING [1]

| Outside diameter (inches) | Nominal wall thickness (inches) | |
|---|---|---|
| | Type A | Type B |
| ⅜ | 0.035 | 0.049 |
| ½ | 0.035 | 0.049 |
| ⅝ | 0.042 | 0.049 |
| ¾ | 0.049 | 0.058 |

[1] Based on data in Standard Specification for Aluminum-Alloy Drawn Seamless Coiled Tubes for Special Purpose Applications, ASTM B210-68.

Aluminum alloy tubing shall be protected against external corrosion when it is in contact with dissimilar metals other than galvanized steel, or its location is subject to repeated wetting by liquids such as water (except rainwater), detergents, sewage, or leakage from other piping, or it passes through flooring, plaster, masonry, or insulation. Galvanized sheet steel or pipe, galvanized inside and out, may be considered suitable protection. The maximum outside diameter for aluminum alloy tubing shall be three-fourths inch and shall not be used for pressures exceeding 20 p.s.i.g. Aluminum alloy tubing shall not be installed within 6 inches of the ground.

(iii) In systems where the gas in liquid form without pressure reduction enters the building, only heavy walled seamless brass or copper tubing with an internal diameter not greater than three thirty-seconds inch, and a wall thickness of not less than three sixty-fourths inch shall be used. This requirement shall not apply to research and experimental laboratories, buildings, or separate fire divisions of buildings used exclusively for housing internal combustion engines, and to commercial gas plants or bulk stations where containers are charged, nor to industrial vaporizer buildings, nor to buildings, structures, or equipment under construction or undergoing major renovation.

(iv) Pipe joints may be screwed, flanged, welded, soldered, or brazed with a material having a melting point exceeding 1,000° F. Joints on seamless copper, brass, steel, or aluminum alloy gas tubing shall be made by means of approved gas tubing fittings, or soldered or brazed with a material having a melting point exceeding 1,000° F.

(v) For operating pressures of 125 p.s.i.g. or less, fittings shall be designed for a pressure of at least 125 p.s.i.g. For operating pressures above 125 p.s.i.g., fittings shall be designed for a minimum of 250 p.s.i.g.

(vi) The use of threaded cast iron pipe fittings such as ells, tees, crosses, couplings, and unions is prohibited. Aluminum alloy fittings shall be used with aluminum alloy pipe and tubing. Insulated fittings shall be used where aluminum alloy pipe or tubing connects with a dissimilar metal.

(vii) Strainers, regulators, meters, compressors, pumps, etc., are not to be considered as pipe fittings. This does not prohibit the use of malleable, nodular, or higher strength gray iron for such equipment.

(viii) All materials such as valve seats, packing, gaskets, diaphragms, etc., shall be of such quality as to be resistant to the action of liquefied petroleum gas under the service conditions to which they are subjected.

(ix) All piping, tubing, or hose shall be tested after assembly and proved free from leaks at not less than normal operating pressures. After installation, piping and tubing of all domestic and commercial systems shall be tested and proved free of leaks using a manometer or equivalent device that will indicate a drop in pressure. Test shall not be made with a flame.

(x) Provision shall be made to compensate for expansion, contraction, jarring, and vibration, and for settling. This may be accomplished by flexible connections.

(xi) Piping outside buildings may be buried, above ground, or both, but shall be well supported and protected against physical damage. Where soil conditions warrant, all piping shall be protected against corrosion. Where condensation may occur, the piping shall be pitched back to the container, or suitable means shall be provided for revaporization of the condensate.

(9) *Hose specifications.* (i) Hose shall be fabricated of materials that are resistant to the action of LP-Gas in the liquid and vapor phases. If wire braid is used for reinforcing the hose, it shall be of corrosion-resistant material such as stainless steel.

(ii) Hose subject to container pressure shall be marked "LP-Gas" or "LPG" at not greater than 10-foot intervals.

(iii) Hose subject to container pressure shall be designed for a bursting pressure of not less than 1,250 p.s.i.g.

(iv) Hose subject to container pressure shall have its correctness as to design construction and performance determined by being listed (see § 1910.110(a)(15)).

(v) Hose connections subject to container pressure shall be capable of withstanding, without leakage, a test pressure of not less than 500 p.s.i.g.

(vi) Hose and hose connections on the low-pressure side of the regulator or reducing valve shall be designed for a bursting pressure of not less than 125 p.s.i.g. or five times the set pressure of the relief devices protecting that portion of the system, whichever is higher.

(vii) Hose may be used on the low-pressure side of regulators to connect to other than domestic and commercial gas appliances under the following conditions:

(*a*) The appliances connected with hose shall be portable and need a flexible connection.

(*b*) For use inside buildings the hose shall be of minimum practical length, but shall not exceed 6 feet except as provided in paragraph (c)(5)(i)(*g*) of this section and shall not extend from one room to another, nor pass through any walls, partitions, ceilings, or floors. Such hose shall not be concealed from view or used in a concealed location. For use outside of buildings, the hose may exceed this length but shall be kept as short as practical.

(*c*) The hose shall be approved and shall not be used where it is likely to be subjected to temperatures above 125° F. The hose shall be securely connected to the appliance and the use of rubber slip ends shall not be permitted.

(*d*) The shutoff valve for an appliance connected by hose shall be in the metal pipe or tubing and not at the appliance end of the hose. When shutoff valves are installed close to each other, precautions shall be taken to prevent operation of the wrong valve.

(*e*) Hose used for connecting to wall outlets shall be protected from physical damage.

(10) *Safety devices.* (i) Every container except those constructed in accordance with DOT specifications and every vaporizer (except motor fuel vaporizers and except vaporizers described in subparagraph (11)(ii)(c) of this paragraph and paragraph (d)(4)(v)(*a*) of this section) whether heated by artificial means or not, shall be provided with one or more safety relief valves of spring-loaded or equivalent type. These valves shall be arranged to afford free vent to the outer air with discharge not less than 5 feet horizontally away from any opening into the building which is below such discharge. The rate of discharge shall be in accordance with the requirements of subdivision (ii) of this subparagraph or subdivision (iii) of this subparagraph in the case of vaporizers.

(ii) Minimum required rate of discharge in cubic feet per minute of air at 120 percent of the maximum permitted start to discharge pressure for safety relief valves to be used on containers other than those constructed in accordance with DOT specification shall be as follows:

| *Surface area (sq. ft.)* | *Flow rate CFM air* |
|---|---|
| 20 or less | 626 |
| 25 | 751 |
| 30 | 872 |
| 35 | 990 |
| 40 | 1,100 |
| 45 | 1,220 |
| 50 | 1,330 |
| 55 | 1,430 |
| 60 | 1,540 |
| 65 | 1,640 |
| 70 | 1,750 |
| 75 | 1,850 |
| 80 | 1,950 |
| 85 | 2,050 |
| 90 | 2,150 |
| 95 | 2,240 |
| 100 | 2,340 |
| 105 | 2,440 |
| 110 | 2,530 |
| 115 | 2,630 |
| 120 | 2,720 |
| 125 | 2,810 |
| 130 | 2,900 |
| 135 | 2,990 |
| 140 | 3,080 |
| 145 | 3,170 |
| 150 | 3,260 |
| 155 | 3,350 |
| 160 | 3,440 |
| 165 | 3,530 |
| 170 | 3,620 |
| 175 | 3,700 |
| 180 | 3,790 |
| 185 | 3,880 |
| 190 | 3,960 |
| 195 | 4,050 |
| 200 | 4,130 |
| 210 | 4,300 |
| 220 | 4,470 |
| 230 | 4,630 |
| 240 | 4,800 |
| 250 | 4,960 |
| 260 | 5,130 |
| 270 | 5,290 |
| 280 | 5,450 |
| 290 | 5,610 |
| 300 | 5,760 |
| 310 | 5,920 |
| 320 | 6,080 |
| 330 | 6,230 |
| 340 | 6,390 |
| 350 | 6,540 |
| 360 | 6,690 |
| 370 | 6,840 |
| 380 | 7,000 |
| 390 | 7,150 |
| 400 | 7,300 |
| 450 | 8,040 |
| 500 | 8,760 |
| 550 | 9,470 |
| 600 | 10,170 |
| 650 | 10,860 |
| 700 | 11,550 |
| 750 | 12,220 |
| 800 | 12,880 |
| 850 | 13,540 |
| 900 | 14,190 |
| 950 | 14,830 |
| 1,000 | 15,470 |
| 1,050 | 16,100 |
| 1,100 | 16,720 |
| 1,150 | 17,350 |
| 1,200 | 17,960 |
| 1,250 | 18,570 |
| 1,300 | 19,180 |
| 1,350 | 19,780 |
| 1,400 | 20,380 |
| 1,450 | 20,980 |
| 1,500 | 21,570 |
| 1,550 | 22,160 |
| 1,600 | 22,740 |
| 1,650 | 23,320 |
| 1,700 | 23,900 |
| 1,750 | 24,470 |
| 1,800 | 25,050 |
| 1,850 | 25,620 |
| 1,900 | 26,180 |
| 1,950 | 26,750 |
| 2,000 | 27,310 |

Surface area=total outside surface area of container in square feet.

When the surface area is not stamped on the nameplate or when the marking is not legible, the area can be calculated by using one of the following formulas:

(1) Cylindrical container with hemispherical heads:

Area=Overall length×outside diameter×3.1416.

(2) Cylindrical container with other than hemispherical heads:

Area=Overall length+0.3 outside diameter ×outside diameter×3.1416.

NOTE: This formula is not exact, but will give results within the limits of practical accuracy for the sole purpose of sizing relief valves.

(3) Spherical container:

Area=Outside diameter squared×3.1416.

Flow Rate-CFM Air=Required flow capacity in cubic feet per minute of air at standard conditions, 60 F. and atmospheric pressure (14.7 p.s.i.a.).

The rate of discharge may be interpolated for intermediate values of surface area. For containers with total outside surface area greater than 2,000 square feet, the required flow rate can be calculated using the formula, Flow Rate-CFM Air=$53.632\ A^{0.82}$.

A=total outside surface area of the container in square feet.

Valves not marked "Air" have flow rate marking in cubic feet per minute of liquefied petroleum gas. These can be converted to ratings in cubic feet per minute of air by multiplying the liquefied petroleum gas ratings by factors listed below. Air flow ratings can be converted to ratings in cubic feet per minute of liquefied petroleum gas by dividing the air ratings by the factors listed below.

AIR CONVERSION FACTORS

| Container type | 100 | 125 | 150 | 175 | 200 |
|---|---|---|---|---|---|
| Air conversion factor | 1.162 | 1.142 | 1.113 | 1.078 | 1.010 |

(iii) Minimum Required Rate of Discharge for Safety Relief Valves for Liquefied Petroleum Gas Vaporizers (Steam Heated, Water Heated, and Direct Fired).

The minimum required rate of discharge for safety relief valves shall be determined as follows:

(*a*) Obtain the total surface area by adding the surface area of vaporizer shell in square feet directly in contact with LP-Gas and the heat exchanged surface area in square feet directly in contact with LP-Gas.

(*b*) Obtain the minimum required rate of discharge in cubic feet of air per minute, at 60° F. and 14.7 p.s.i.a. from subdivision (ii) of this subparagraph, for this total surface area.

(iv) Container and vaporizer safety relief valves shall be set to start-to-discharge, with relation to the design pressure of the container, in accordance with Table H–26.

TABLE H–26

| Containers | Minimum (percent) | Maximum (percent) |
|---|---|---|
| ASME Code; Par. U–68, U–69—1949 and earlier editions | 110 | [1]125 |
| ASME Code; Par. U–200, U–201—1949 edition | 88 | [1]100 |
| ASME Code—1950, 1952, 1956, 1959, 1962, 1965 and 1968 (Division I) editions | 88 | [1]100 |
| API—ASME Code—all editions | 88 | [1]100 |
| DOT—As prescribed in 49 CFR Chapter I | | |

[1]Manufacturers of safety relief valves are allowed a plus tolerance not exceeding 10 percent of the set pressure marked on the valve.

(v) Safety relief devices used with systems employing containers other than those constructed according to DOT specifications shall be so constructed as to discharge at not less than the rates shown in subdivision (ii) of this subparagraph, before the pressure is in excess of 120 percent of the maximum (not including the 10 percent referred to in subdivision (iv) of this subparagraph) permitted start to discharge pressure setting of the device.

(vi) In certain locations sufficiently sustained high temperatures prevail which require the use of a lower vapor pressure product to be stored or the use of a higher designed pressure vessel in order to prevent the safety valves opening as the result of these temperatures. As an alternative the tanks may be protected by cooling devices such as by spraying, by shading, or other effective means.

(vii) Safety relief valves shall be arranged so that the possibility of tampering will be minimized. If pressure setting or adjustment is external, the relief valves shall be provided with approved means for sealing adjustment.

(viii) Shutoff valves shall not be installed between the safety relief devices and the container, or the equipment or piping to which the safety relief device is connected except that a shutoff valve may be used where the arrangement of this valve is such that full required capacity flow through the safety relief device is always afforded.

(ix) Safety relief valves shall have direct communication with the vapor space of the container at all times.

(x) Each container safety relief valve used with systems covered by paragraphs (d), (e), (g), and (h) of this section, except as provided in paragraph (e)(3)(iii) of this section shall be plainly and permanently marked with the following: "Container Type" of the pressure vessel on which the valve is designed to be installed; the pressure in p.s.i.g. at which the valve is set to discharge; the actual rate of discharge of the valve in cubic feet per minute of air at 60° F. and 14.7 p.s.i.a.; and the manufacturer's name and catalog number, for example: T200–250–4050 AIR—indicating that the valve is suitable for use on a Type 200 container, that it is set to start to discharge at 250 p.s.i.g.; and that its rate of discharge is 4,050 cubic feet per minute of air as determined in subdivision (ii) of this subparagraph.

(xi) Safety relief valve assemblies, including their connections, shall be of sufficient size so as to provide the rate of flow required for the container on which they are installed.

(xii) A hydrostatic relief valve shall be installed between each pair of shutoff valves on liquefied petroleum gas liquid piping so as to relieve into a safe atmosphere. The start-to-discharge pressure setting of such relief valves shall not be in excess of 500 p.s.i.g. The minimum setting on relief valves installed in piping connected to other than DOT containers shall not be lower than 140 percent of the container relief valve setting and in piping connected to DOT containers not lower than 400 p.s.i.g. Such a relief valve should not be installed in the pump discharge piping if the same protection can be provided by installing the relief valve in the suction piping. The start-to-discharge pressure setting of such a relief valve, if installed on the discharge side of a pump, shall be greater than the maximum pressure permitted by the recirculation device in the system.

(xiii) The discharge from any safety relief device shall not terminate in or beneath any building, except relief devices covered by subparagraphs (6)(i)(*a*)–(*e*) of this paragraph or paragraphs (c) (4)(i) or (5) of this section.

(xiv) Container safety relief devices and regulator relief vents shall be located not less than five (5) feet in any direction from air openings into sealed combustion system appliances or mechanical ventilation air intakes.

(11) *Vaporizer and housing.* (i) Indirect fired vaporizers utilizing steam, water, or other heating medium shall be constructed and installed as follows:

(*a*) Vaporizers shall be constructed in accordance with the requirements of subparagraph (3) (i)–(iii) of this paragraph and shall be permanently marked as follows:

(*1*) With the code marking signifying the specifications to which the vaporizer is constructed.

(*2*) With the allowable working pressure and temperature for which the vaporizer is designed.

(*3*) With the sum of the outside surface area and the inside heat exchange surface area expressed in square feet.

(*4*) With the name or symbol of the manufacturer.

(*b*) Vaporizers having an inside diameter of 6 inches or less exempted by the ASME Unfired Pressure Vessel Code, Section VIII of the ASME Boiler and Pressure Vessel Code—1968 shall have a design pressure not less than 250 p.s.i.g. and need not be permanently marked.

(*c*) Heating or cooling coils shall not be installed inside a storage container.

(*d*) Vaporizers may be installed in buildings, rooms, sheds, or lean-tos used exclusively for gas manufacturing or distribution, or in other structures of light, noncombustible construction or equivalent, well ventilated near the floor line and roof.

When vaporizing and/or mixing equipment is located in a structure or building not used exclusively for gas manufacturing or distribution, either attached to or within such a building, such structure or room shall be separated from the remainder of the building by a wall designed to withstand a static pressure of at least 100 pounds per square foot. This wall shall have no openings or pipe or conduit passing through it. Such structure or room shall be provided with adequate ventilation and shall have a roof or at least one exterior wall of lightweight construction.

(*e*) Vaporizers shall have, at or near the discharge, a safety relief valve providing an effective rate of discharge in accordance with subparagraph (10)(iii) of this paragraph, except as provided in paragraph (d)(4)(v)(*a*), of this section.

(*f*) The heating medium lines into and leaving the vaporizer shall be provided with suitable means for preventing the flow of gas into the heat systems in the event of tube rupture in the vaporizer. Vaporizers shall be provided with suitable automatic means to prevent liquid passing through the vaporizers to the gas discharge piping.

(*g*) The device that supplies the necessary heat for producing steam, hot water, or other heating medium may be installed in a building, compartment, room, or lean-to which shall be

ventilated near the floorline and roof to the outside. The device location shall be separated from all compartments or rooms containing liquefied petroleum gas vaporizers, pumps, and central gas mixing devices by a wall designed to withstand a static pressure of at least 100 pounds per square foot. This wall shall have no openings or pipes or conduit passing through it. This requirement does not apply to the domestic water heaters which may supply heat for a vaporizer in a domestic system.

(*h*) Gas-fired heating systems supplying heat exclusively for vaporization purposes shall be equipped with automatic safety devices to shut off the flow of gas to main burners, if the pilot light should fail.

(*i*) Vaporizers may be an integral part of a fuel storage container directly connected to the liquid section or gas section or both.

(*j*) Vaporizers shall not be equipped with fusible plugs.

(*k*) Vaporizer houses shall not have unprotected drains to sewers or sump pits.

(ii) Atmospheric vaporizers employing heat from the ground or surrounding air shall be installed as follows:

(*a*) Buried underground, or

(*b*) Located inside the building close to a point at which pipe enters the building provided the capacity of the unit does not exceed 1 quart.

(*c*) Vaporizers of less than 1 quart capacity heated by the ground or surrounding air, need not be equipped with safety relief valves provided that adequate tests demonstrate that the assembly is safe without safety relief valves.

(iii) Direct gas-fired vaporizers shall be constructed, marked, and installed as follows:

(*a*)(*1*) In accordance with the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code—1968 that are applicable to the maximum working conditions for which the vaporizer is designed.

(*2*) With the name of the manufacturer; rated BTU input to the burner; the area of the heat exchange surface in square feet; the outside surface of the vaporizer in square feet; and the maximum vaporizing capacity in gallons per hour.

(*b*)(*1*) Vaporizers may be connected to the liquid section or the gas section of the storage container, or both; but in any case there shall be at the container a manually operated valve in each connection to permit completely shutting off when desired, of all flow of gas or liquid from container to vaporizer.

(*2*) Vaporizers with capacity not exceeding 35 gallons per hour shall be located at least 5 feet from container shutoff valves. Vaporizers having capacity of more than 35 gallons but not exceeding 100 gallons per hour shall be located at least 10 feet from the container shutoff valves. Vaporizers having a capacity greater than 100 gallons per hour shall be located at least 15 feet from container shutoff valves.

(*c*) Vaporizers may be installed in buildings, rooms, housings, sheds, or lean-tos used exclusively for vaporizing or mixing of liquefied petroleum gas. Vaporizing housing structures shall be of noncombustible construction, well ventilated near the floorline and the highest point of the roof. When vaporizer and/or mixing equipment is located in a structure or room attached to or within a building, such structure or room shall be separated from the remainder of the building by a wall designed to withstand a static pressure of at least 100 pounds per square foot. This wall shall have no openings or pipes or conduit passing through it. Such structure or room shall be provided with adequate ventilation, and shall have a roof or at least one exterior wall of lightweight construction.

(*d*) Vaporizers shall have at or near the discharge, a safety relief valve providing an effective rate of discharge in accordance with subparagraph (10)(iii) of this paragraph. The relief valve shall be so located as not to be subjected to temperatures in excess of 140° F.

(*e*) Vaporizers shall be provided with suitable automatic means to prevent liquid passing from the vaporizer to the gas discharge piping of the vaporizer.

(*f*) Vaporizers shall be provided with means for manually turning off the gas to the main burner and pilot.

(*g*) Vaporizers shall be equipped with automatic safety devices to shut off the flow of gas to main burners if the pilot light should fail. When the flow through the pilot exceeds 2,000 B.t.u. per hour, the pilot also shall be equipped with an automatic safety device to shut off the flow of gas to the pilot should the pilot flame be extinguished.

(*h*) Pressure regulating and pressure reducing equipment if located within 10 feet of a direct fire vaporizer shall be separated from the open flame by a substantially airtight noncombustible partition or partitions.

(*i*) Except as provided in (*c*) of this subdivision, the following minimum distances shall be maintained between direct fired vaporizers and the nearest important building or group of buildings or line of adjoining property which may be built upon:

Ten feet for vaporizers having a capacity of 15 gallons per hour or less vaporizing capacity.

Twenty-five feet for vaporizers having a vaporizing capacity of 16 to 100 gallons per hour.

Fifty feet for vaporizers having a vaporizing capacity exceeding 100 gallons per hour.

(*j*) Direct fired vaporizers shall not raise the product pressure above the design pressure of the vaporizer equipment nor shall they raise the product pressure within the storage container above the pressure shown in the second column of Table H-31.

(*k*) Vaporizers shall not be provided with fusible plugs.

(*l*) Vaporizers shall not have unprotected drains to sewers or sump pits.

(iv) Direct gas-fired tank heaters shall be constructed and installed as follows:

(*a*) Direct gas-fired tank heaters, and tanks to which they are applied, shall only be installed above ground.

(*b*) Tank heaters shall be permanently marked with the name of the manufacturer, the rated B.t.u. input to the burner, and the maximum vaporizing capacity in gallons per hour.

(*c*) Tank heaters may be an integral part of a fuel storage container directly connected to the container liquid section, or vapor section, or both.

(*d*) Tank heaters shall be provided with a means for manually turning off the gas to the main burner and pilot.

(*e*) Tank heaters shall be equipped with an automatic safety device to shut off the flow of gas to main burners, if the pilot light should fail. When flow through pilot exceeds 2,000 B.t.u. per hour, the pilot also shall be equipped with an automatic safety device to shut off the flow of gas to the pilot should the pilot flame be extinguished.

(*f*) Pressure regulating and pressure reducing equipment if located within 10 feet of a direct fired tank heater shall be separated from the open flame by a substantially airtight noncombustible partition.

(*g*) The following minimum distances shall be maintained between a storage tank heated by a direct fired tank heater and the nearest important building or group of buildings or line of adjoining property which may be built upon:

Ten feet for storage containers of less than 500 gallons water capacity.

Twenty-five feet for storage containers of 500 to 1,200 gallons water capacity.

Fifty feet for storage containers of over 1,200 gallons water capacity.

(*h*) No direct fired tank heater shall raise the product pressure within the storage container over 75 percent of the pressure set out in the second column of Table H-31.

(v) The vaporizer section of vaporizer-burners used for dehydrators or dryers shall be located outside of buildings; they shall be constructed and installed as follows:

(a) Vaporizer-burners shall have a minimum design pressure of 250 p.s.i.g. with a factor of safety of five.

(b) Manually operated positive shutoff valves shall be located at the containers to shut off all flow to the vaporizer-burners.

(c) Minimum distances between storage containers and vaporizer-burners shall be as follows:

| *Water capacity per container (gallons)* | *Minimum distances (feet)* |
|---|---|
| Less than 501 | 10 |
| 501 to 2,000 | 25 |
| Over 2,000 | 50 |

(d) The vaporizer section of vaporizer-burners shall be protected by a hydrostatic relief valve. The relief valve shall be located so as not to be subjected to temperatures in excess of 140° F. The start-to-discharge pressure setting shall be such as to protect the components involved, but not less than 250 p.s.i.g. The discharge shall be directed upward and away from component parts of the equipment and away from operating personnel.

(e) Vaporizer-burners shall be provided with means for manually turning off the gas to the main burner and pilot.

(f) Vaporizer-burners shall be equipped with automatic safety devices to shut off the flow of gas to the main burner and pilot in the event the pilot is extinguished.

(g) Pressure regulating and control equipment shall be located or protected so that the temperatures surrounding this equipment shall not exceed 140° F. except that equipment components may be used at higher temperatures if designed to withstand such temperatures.

(h) Pressure regulating and control equipment when located downstream of the vaporizer shall be designed to withstand the maximum discharge temperature of the vapor.

(i) The vaporizer section of vaporizer-burners shall not be provided with fusible plugs.

(j) Vaporizer coils or jackets shall be made of ferrous metal or high temperature alloys.

(k) Equipment utilizing vaporizer-burners shall be equipped with automatic shutoff devices upstream and downstream of the vaporizer section connected so as to operate in the event of excessive temperature, flame failure, and, if applicable, insufficient airflow.

(12) *Filling densities.* (i) The "filling density" is defined as the percent ratio of the weight of the gas in a container to the weight of water the container will hold at 60° F. All containers shall be filled according to the filling densities shown in Table H-27.

TABLE H-27—MAXIMUM PERMITTED FILLING DENSITY

| Specific gravity at 60° F. (15.6° C.) | Above ground containers | | Under ground containers, all capacities |
|---|---|---|---|
| | 0 to 1,200 U.S. gals. (1,000 imp. gal., 4,550 liters) total water cap. | Over 1,200 U.S. gals. (1,000 imp. gal., 4,550 liters) total water cap. | |
| | *Percent* | *Percent* | *Percent* |
| 0.496–0.503 | 41 | 44 | 45 |
| .504– .510 | 42 | 45 | 46 |
| .511– .519 | 43 | 46 | 47 |
| .520– .527 | 44 | 47 | 48 |
| .528– .536 | 45 | 48 | 49 |
| .537– .544 | 46 | 49 | 50 |
| .545– .552 | 47 | 50 | 51 |
| .553– .560 | 48 | 51 | 52 |
| .561– .568 | 49 | 52 | 53 |
| .569– .576 | 50 | 53 | 54 |
| .577– .584 | 51 | 54 | 55 |
| .585– .592 | 52 | 55 | 56 |
| .593– .600 | 53 | 56 | 57 |

(ii) Except as provided in subparagraph (iii) of this subparagraph, any container including mobile cargo tanks and portable tank containers regardless of size or construction, shipped under DOT jurisdiction or constructed in accordance with 49 CFR Chapter I Specifications shall be charged according to 49 CFR Chapter I requirements.

(iii) Portable containers not subject to DOT jurisdiction (such as, but not limited to, motor fuel containers on industrial and lift trucks, and farm tractors covered in paragraph (e) of this section, or containers recharged at the installation) may be filled either by weight, or by volume using a fixed length dip tube gaging device.

(13) *LP-Gas in buildings.* (i) Vapor shall be piped into buildings at pressures in excess of 20 p.s.i.g. only if the buildings or separate areas thereof, (a) Are constructed in accordance with this section; (b) Are used excusively to house equipment for vaporization, pressure reduction, gas mixing, gas manufacturing, or distribution, or to house internal combustion engines, industrial processes, research and experimental laboratories, or equipment and processes using such gas and having similar hazard; (c) Buildings, structures, or equipment under construction or undergoing major renovation.

(ii) Liquid may be permitted in buildings as follows:

(a) Buildings, or separate areas of buildings, used exclusively to house equipment for vaporization, pressure reduction, gas mixing, gas manufacturing, or distribution, or to house internal combustion engines, industrial processes, research and experimental laboratories, or equipment and processes using such gas and having similar hazard; and when such buildings, or separate areas thereof are constructed in accordance with this section.

(b) Buildings, structures, or equipment under construction or undergoing major renovation provided the temporary piping meets the following conditions:

(1) Liquid piping inside the building shall conform to the requirements of subparagraph (8) of this paragraph, and shall not exceed three-fourths iron pipe size. Copper tubing with an outside diameter of three-fourths inch or less may be used provided it conforms to Type K of Specifications for Seamless Water Tube, ANSI H23.1-1970 (ASTM B88-69) (see Table H-24). All such piping shall be protected against construction hazards. Liquid piping inside buildings shall be kept to a minimum. Such piping shall be securely fastened to walls or other surfaces so as to provide adequate protection from breakage and so located as to subject the liquid line to lowest ambient temperatures.

(2) A shutoff valve shall be installed in each intermediate branch line where it takes off the main line and shall be readily accessible. A shutoff valve shall also be placed at the appliance end of the intermediate branch line. Such shutoff valve shall be upstream of any flexible connector used with the appliance.

(3) Suitable excess flow valves shall be installed in the container outlet line supplying liquid LP-Gas to the building. A suitable excess flow valve shall be installed immediately downstream of each shutoff valve. Suitable excess flow valves shall be installed where piping size is reduced and shall be sized for the reduced size piping.

(4) Hydrostatic relief valves shall be installed in accordance with subparagraph (10)(xii) of this section.

(5) The use of hose to carry liquid between the container and the building or at any point in the liquid line, except at the appliance connector, shall be prohibited.

(6) Where flexible connectors are necessary for appliance installation, such connectors shall be as short as practicable and shall comply with subparagraph (8)(ii) or (9) of this paragraph.

(7) Release of fuel when any section of piping or appliances is disconnected shall be minimized by either of the following methods:

(i) Using an approved automatic quick-closing coupling (a type closing in both directions when coupled in the fuel line), or

(ii) Closing the valve nearest to the appliance and allowing the appliance to operate until the fuel in the line is consumed.

(iii) Portable containers shall not be taken into buildings except as pro-

vided in subparagraph (6)(i) of this paragraph.

(14) *Transfer of liquids.* The employer shall assure that—(i) at least one attendant shall remain close to the transfer connection from the time the connections are first made until they are finally disconnected, during the transfer of the product.

(ii) Containers shall be filled or used only upon authorization of the owner.

(iii) Containers manufactured in accordance with specifications of 49 CFR Part 178 and authorized by 49 CFR Chapter 1 as a "single trip" or "nonrefillable container" shall not be refilled or reused in LP-Gas service.

(iv) Gas or liquid shall not be vented to the atmosphere to assist in transferring contents of one container to another, except as provided in paragraph (e)(5)(iv) of this section and except that this shall not preclude the use of listed pump utilizing LP-Gas in the vapor phase as a source of energy and venting such gas to the atmosphere at a rate not to exceed that from a No. 31 drill size opening and provided that such venting and liquid transfer shall be located not less than 50 feet from the nearest important building.

(v) Filling of fuel containers for industrial trucks or motor vehicles from industrial bulk storage containers shall be performed not less than 10 feet from the nearest important masonry-walled building or not less than 25 feet from the nearest important building or other construction and, in any event, not less than 25 feet from any building opening.

(vi) Filling of portable containers, containers mounted on skids, fuel containers on farm tractors, or similar applications, from storage containers used in domestic or commercial service, shall be performed not less than 50 feet from the nearest important building.

(vii) The filling connection and the vent from the liquid level gages in containers, filled at point of installation, shall not be less than 10 feet in any direction from air openings into sealed combustion system appliances or mechanical ventilation air intakes.

(viii) Fuel supply containers shall be gaged and charged only in the open air or in buildings especially provided for that purpose.

(ix) The maximum vapor pressure of the product at 100° F. which may be transferred into a container shall be in accordance with paragraphs (d)(2) and (e)(3) of this section. (For DOT containers use DOT requirements.)

(x) Marketers and users shall exercise precaution to assure that only those gases for which the system is designed, examined, and listed, are employed in its operation, particularly with regard to pressures.

(xi) Pumps or compressors shall be designed for use with LP-Gas. When compressors are used they shall normally take suction from the vapor space of the container being filled and discharge to the vapor space of the container being emptied.

(xii) Pumping systems, when equipped with a positive displacement pump, shall include a recirculating device which shall limit the differential pressure on the pump under normal operating conditions to the maximum differential pressure rating of the pump. The discharge of the pumping system shall be protected so that pressure does not exceed 350 p.s.i.g. If a recirculation system discharges into the supply tank and contains a manual shutoff valve, an adequate secondary safety recirculation system shall be incorporated which shall have no means of rendering it inoperative. Manual shutoff valves in recirculation systems shall be kept open except during an emergency or when repairs are being made to the system.

(xiii) When necessary, unloading piping or hoses shall be provided with suitable bleeder valves for relieving pressure before disconnection.

(xiv) Agricultural air moving equipment, including crop dryers, shall be shut down when supply containers are being filled unless the air intakes and sources of ignition on the equipment are located 50 feet or more from the container.

(xv) Agricultural equipment employing open flames or equipment with integral containers, such as flame cultivators, weed burners, and, in addition, tractors, shall be shut down during refueling.

(15) *Tank car or transport truck loading or unloading points and operations.* (i) The track of tank car siding shall be relatively level.

(ii) A "Tank Car Connected" sign, as covered by DOT rules, shall be installed at the active end or ends of the siding while the tank car is connected.

(iii) While cars are on sidetrack for loading or unloading, the wheels at both ends shall be blocked on the rails.

(iv) The employer shall insure that an employee is in attendance at all times while the tank car, cars, or trucks are being loaded or unloaded.

(v) A backflow check valve, excess-flow valve, or a shutoff valve with means of remote closing, to protect against uncontrolled discharge of LP-Gas from storage tank piping shall be installed close to the point where the liquid piping and hose or swing joint pipe is connected.

(vi) Except as provided in subdivision (vii) of this subparagraph, when the size (diameter) of the loading or unloading hoses and/or piping is reduced below the size of the tank car or transport truck loading or unloading connections, the adaptors to which lines are attached shall be equipped with either a backflow check valve, a properly sized excess flow valve, or shutoff valve with means of remote closing, to protect against uncontrolled discharge from the tank car or transport truck.

(vii) The requirement of subdivision (vi) of this subparagraph shall not apply if the tank car or transport is equipped with a quick-closing internal valve that can be remotely closed.

(viii) The tank car or transport truck loading or unloading point shall be located with due consideration to the following:

(*a*) Proximity to railroads and highway traffic.

(*b*) The distance of such unloading or loading point from adjacent property.

(*c*) With respect to buildings on installer's property.

(*d*) Nature of occupancy.

(*e*) Topography.

(*f*) Type of construction of buildings.

(*g*) Number of tank cars or transport trucks that may be safely loaded or unloaded at one time.

(*h*) Frequency of loading or unloading.

(ix) Where practical, the distance of the unloading or loading point shall conform to the distances in subparagraph (6)(ii) of this paragraph.

(16) *Instructions.* Personnel performing installation, removal, operation, and maintenance work shall be properly trained in such function.

(17) *Electrical equipment and other sources of ignition.* (i) Electrical equipment and wiring shall be of a type specified by and shall be installed in accordance with Subpart S of this part, for ordinary locations except that fixed electrical equipment in classified areas shall comply with subparagraph (18) of this paragraph.

(ii) Open flames or other sources of ignition shall not be permitted in vaporizer rooms (except those housing direct-fired vaporizers), pumphouses, container charging rooms or other similar locations. Direct-fired vaporizers shall not be permitted in pumphouses or container charging rooms.

(iii) Liquefied petroleum gas storage containers do not require lightning protection.

(iv) Since liquefied petroleum gas is contained in a closed system of piping and equipment, the system need not be electrically conductive or electrically bonded for protection against static electricity.

(v) Open flames (except as provided for in subparagraph (11) of this paragraph), cutting or welding, portable electric tools, and extension lights capable of igniting LP-Gas, shall not be permitted within classified areas speci-

fied in Table H-28 unless the LP-Gas facilities have been freed of all liquid and vapor, or special precautions observed under carefully controlled conditions.

(18) *Fixed electrical equipment in classified areas.* Fixed electrical equipment and wiring installed within classified areas specified in Table H-28 shall comply with Table H-28 and shall be installed in accordance with Subpart S of this part. This provision does not apply to fixed electrical equipment at residential or commercial installations of LP-Gas systems or to systems covered by paragraph (e) or (g) of this section.

TABLE H-28

| Part | Location | Extent of classified area [1] | Equipment shall be suitable for National Electrical Code, Class 1, Group D [2] |
|---|---|---|---|
| A | Storage containers other than DOT cylinders. | Within 15 feet in all directions from connections, except connections otherwise covered in Table H-28. | Division 2. |
| B | Tank vehicle and tank car loading and unloading. [3] | Within 5 feet in all directions from connections regularly made or disconnected for product transfer. | Division 1. |
| | | Beyond 5 feet but within 15 feet in all directions from a point where connections are regularly made or disconnected and within the cylindrical volume between the horizontal equator of the sphere and grade. (See Figure H-1). | Division 2. |
| C | Gage vent openings other than those on DOT cylinders. | Within 5 feet in all directions from point of discharge. | Division 1. |
| | | Beyond 5 feet but within 15 feet in all directions from point of discharge. | Division 2. |
| D | Relief valve discharge other than those on DOT cylinders. | Within direct path of discharge. | Division 1. *Note*— Fixed electrical equipment should preferably not be installed. |
| | | Within 5 feet in all directions from point of discharge. | Division 1. |
| | | Beyond 5 feet but within 15 feet in all directions from point of discharge except within the direct path of discharge. | Division 2. |
| E | Pumps, compressors, gas-air mixers and vaporizers other than direct fired. | | |
| | Indoors without ventilation. | Entire room and any adjacent room not separated by a gastight partition. | Division 1. |
| | | Within 15 feet of the exterior side of any exterior wall or roof that is not vaportight or within 15 feet of any exterior opening. | Division 2. |
| | Indoors with adequate ventilation. [4] | Entire room and any adjacent room not separated by a gastight partition. | Division 2. |
| | Outdoors in open air at or abovegrade. | Within 15 feet in all directions from this equipment and within the cylindrical volume between the horizontal equator of the sphere and grade. See Figure H-1. | Division 2. |
| F | Service Station Dispensing Units. | Entire space within dispenser enclosure, and 18 inches horizontally from enclosure exterior up to an elevation 4 ft. above dispenser base. Entire pit or open space beneath dispenser. | Division 1. |
| | | Up to 18 inches abovegrade within 20 ft. horizontally from any edge of enclosure. | Division 2. |
| | | NOTE: For pits within this area, see Part F of this table. | |
| G | Pits or trenches containing or located beneath LP-Gas valves, pumps, compressors, regulators, and similar equipment. | | |
| | Without mechanical ventilation. | Entire pit or trench. | Division 1. |
| | | Entire room and any adjacent room not separated by a gastight partition. | Division 2. |
| | | Within 15 feet in all directions from pit or trench when located outdoors. | Division 2. |
| | With adequate mechanical ventilation. | Entire pit or trench. | Division 2. |
| | | Entire room and any adjacent room not separated by a gastight partition. | Division 2. |
| | | Within 15 feet in all directions from pit or trench when located outdoors. | Division 2. |

TABLE H-2[2]—Continued

| Part | Location | Extent of classified area [1] | Equipment shall be suitable for National Electrical Code, Class 1, Group D [2] |
|---|---|---|---|
| H | Special buildings or rooms for storage of portable containers. | Entire room | Division 2. |
| I | Pipelines and connections containing operational bleeds, drips, vents or drains. | Within 5 ft. in all directions from point of discharge. | Division 1. |
| | | Beyond 5 ft. from point of discharge, same as Part E of this table. | |
| J | Container filling: | | |
| | Indoors without ventilation. | Entire room | Division 1. |
| | Indoors with adequate ventilation. [4] | Within 5 feet in all directions from connections regularly made or disconnected for product transfer. | Division 1. |
| | | Beyond 5 feet and entire room | Division 2. |
| | Outdoors in open air | Within 5 feet in all directions from connections regularly made or disconnected for product transfer. | Division 1. |
| | | Beyond 5 feet but within 15 feet in all directions from a point where connections are regularly made or disconnected and within the cylindrical volume between the horizontal equator of the sphere and grade. (See Figure H-1) | Division 2. |

[1] The classified area shall not extend beyond an unpierced wall, roof, or solid vaportight partition.
[2] See Subpart S of this part.
[3] When classifying extent of hazardous area, consideration shall be given to possible variations in the spotting of tank cars and tank vehicles at the unloading points and the effect these variations of actual spotting point may have on the point of connection.
[4] Ventilation, either natural or mechanical, is considered adequate when the concentration of the gas in a gas-air mixture does not exceed 25 percent of the lower flammable limit under normal operating conditions.

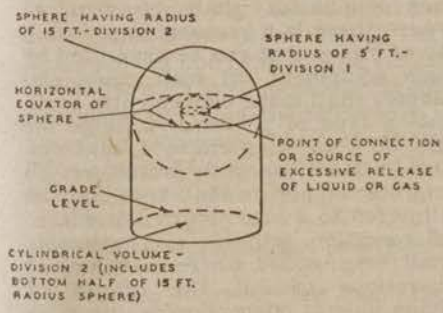



Figure H-1

(19) *Liquid-level gaging device.* (i) Each container manufactured after December 31, 1965, and filled on a volumetric basis shall be equipped with a fixed liquid-level gage to indicate the maximum permitted filling level as provided in subdivision (v) of this subparagraph. Each container manufactured after December 31, 1969, shall have permanently attached to the container adjacent to the fixed level gage a marking showing the percentage full that will be shown by that gage. When a variable liquid-level gage is also provided, the fixed liquid-level gage will also serve as a means for checking the variable gage. These gages shall be used in charging containers as required in subparagraph (12) of this section.

(ii) All variable gaging devices shall be arranged so that the maximum liquid level for butane, for a 50-50 mixture of butane and propane, and for propane, to which the container may be charged is readily determinable. The markings indicating the various liquid levels from empty to full shall be on the system nameplate or gaging device or part may be on the system nameplate and part on the gaging device. Dials of magnetic or rotary gages shall show whether they are for cylindrical or spherical containers and whether for aboveground or underground service. The dials of gages intended for use only on aboveground containers of over 1,200 gallons water capacity shall be so marked.

(iii) Gaging devices that require bleeding of the product to the atmosphere, such as the rotary tube, fixed tube, and slip tube, shall be designed so that the bleed valve maximum opening is not larger than a No. 54 drill size, unless provided with excess flow valve.

(iv) Gaging devices shall have a design working pressure of at least 250 p.s.i.g.

(v) Length of tube or position of fixed liquid-level gage shall be designed to indicate the maximum level to which the container may be filled for the product contained. This level shall be based on the volume of the product at 40° F. at its maximum permitted filling density for aboveground containers and at 50° F. for underground containers. The employer shall calculate the filling point for which the fixed liquid level gage shall be designed according to the method in this subdivision.

(*a*) It is impossible to set out in a table the length of a fixed dip tube for various capacity tanks because of the varying tank diameters and lengths and because the tank may be installed either in a vertical or horizontal position. Knowing the maximum permitted filling volume in gallons, however, the length of the fixed tube can be determined by the use of a strapping table obtained from the container manufacturer. The length of the fixed tube should be such that when its lower end touches the surface of the liquid in the container, the contents of the container will be the maximum permitted volume as determined by the following formula:

(*b*) Formula for determining maximum volume of liquefied petroleum gas for which a fixed length of dip tube shall be set:

[(Water capacity (gals.) of container* × filling density**) ÷ (Specific gravity of LP-Gas* × volume correction factor† × 100)] = Maximum volume of LP-Gas

*Measured at 60° F.

**From subparagraph (12) of this paragraph "Filling Densities."

†For aboveground containers the liquid temperature is assumed to be 40° F. and for underground containers the liquid temperature is assumed to be 50° F. To correct the liquid volumes at these temperatures to 60° F. the following factors shall be used:

TABLE H-29—VOLUME CORRECTION FACTORS

| Specific gravity | Aboveground | Underground |
|---|---|---|
| 0.500 | 1.033 | 1.017 |
| .510 | 1.031 | 1.016 |
| .520 | 1.029 | 1.015 |
| .530 | 1.028 | 1.014 |
| .540 | 1.026 | 1.013 |
| .550 | 1.025 | 1.013 |
| .560 | 1.024 | 1.012 |
| .570 | 1.023 | 1.011 |
| .580 | 1.021 | 1.011 |
| .590 | 1.020 | 1.010 |

(*c*) The maximum volume of LP-Gas which can be placed in a container when determining the length of the dip tube expressed as a percentage of total water content of the container is calculated by the following formula.

(*d*) The maximum weight of LP-Gas which may be placed in a container *for determining the length of a fixed dip tube* is determined by multiplying the maximum volume of liquefied petroleum gas obtained by the formula in (*b*) of this subdivision by the pounds of liquefied petroleum gas in a gallon at 40° F. for abovegound and at 50° F. for underground containers. For example, typical pounds per gallon are specified below:

Example: Assume a 100-gallon total water capacity tank for aboveground storage of propane having a specific gravity of 0.510 of 60° F.

[(100 (gals.)×42 (filling density from subparagraph (12) of this paragraph))÷(0.510×1.031 (correction factor from Table H-29)×100)]=(4200÷52.6)

(4200÷52.6)=79.8 gallons propane, the maximum amount permitted to be placed in a 100-gallon total water capacity aboveground container equipped with a fixed dip tube.

[(Maximum volume of LP-Gas (from formula in subdivision *(b)* of this subdivision) ×100)÷Total water content of container in gallons]=Maximum percent of LP-Gas

| | Aboveground, pounds per gallon | Underground, pounds per gallon |
|---|---|---|
| Propane | 4.37 | 4.31 |
| N Butane | 4.97 | 4.92 |

(vi) Fixed liquid-level gages used on containers other than DOT containers shall be stamped on the exterior of the gage with the letters "DT" followed by the vertical distance (expressed in inches and carried out to one decimal place) from the top of container to the end of the dip tube or to the centerline of the gage when it is located at the maximum permitted filling level. For portable containers that may be filled in the horizontal and/or vertical position the letters "DT" shall be followed by "V" with the vertical distance from the top of the container to the end of the dip tube for vertical filling and with "H" followed by the proper distance for horizontal filling. For DOT containers the stamping shall be placed both on the exterior of the gage and on the container. On aboveground or cargo containers where the gages are positioned at specific levels, the marking may be specified in percent of total tank contents and the marking shall be stamped on the container.

(vii) Gage glasses of the columnar type shall be restricted to charging plants where the fuel is withdrawn in the liquid phase only. They shall be equipped with valves having metallic handwheels, with excess flow valves, and with extra-heavy glass adequately protected with a metal housing applied by the gage manufacturer. They shall be shielded against the direct rays of the sun. Gage glasses of the columnar type are prohibited on tank trucks, and on motor fuel tanks, and on containers used in domestic, commercial, and industrial installations.

(viii) Gaging devices of the float, or equivalent type which do not require flow for their operation and having connections extending to a point outside the container do not have to be equipped with excess flow valves provided the piping and fittings are adequately designed to withstand the container pressure and are properly protected against physical damage and breakage.

(20) *Requirements for appliances.* (i) Except as provided in subdivision (ii) of this subparagraph, new commercial and industrial gas consuming appliances shall be approved.

(ii) Any appliance that was originally manufactured for operation with a gaseous fuel other than LP-Gas and is in good condition may be used with LP-Gas only after it is properly converted, adapted, and tested for performance with LP-Gas before the appliance is placed in use.

(iii) Unattended heaters used inside buildings for the purpose of animal or poultry production or care shall be equipped with an approved automatic device designed to shut off the flow of gas to the main burners, and pilot if used, in the event of flame extinguishment.

(iv) All commercial, industrial, and agricultural appliances or equipment shall be installed in accordance with the requirements of this section and in accordance with the following:

(*a*) Domestic and commercial appliances—NFPA 54-1969, Standard for the Installation of Gas Appliances and Gas Piping.

(*b*) Industrial appliances—NFPA 54A-1969, Standard for the Installation of Gas Piping and Gas Equipment on Industrial Premises and Certain Other Premises.

(*c*) Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines—NFPA 37-1970.

(*d*) Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment, NFPA 96-1970.

## HEALTH STANDARDS

Sec.

1910.6 Incorporation by reference.
1910.100 Standards organizations.
1910.133 Eye and face protection.
1910.135 Occupational head protection.
1910.136 Occupational foot protection.
1910.141(d) Washing facilities.
1910.141(e) Change rooms.
1910.145(d)(4) Caution signs.
1910.184(d) Inspections (slings).

### § 1910.6 Incorporation by reference.

(a) The standards of agencies of the U.S. Government and organizations which are not agencies of the U.S. Government which are legally incorporated by reference in this part, have the same force and effect as other standards in this part.

(b) Copies of the standards which are incorporated by reference may be examined at the national office of the Occupational Safety and Health Administration, U.S. Department of Labor, Washington, D.C. 20210, or at any of its regional offices. Copies of such private standards may be obtained from the issuing organizations. Their names and addresses are listed in the pertinent subparts of this part.

(c) Any changes in the standards incorporated by reference in this part and an official historic file of such changes are available for inspection at the national office of the Occupational Safety and Health Administration, U.S. Department of Labor, Washington, D.C. 202110.

### § 1910.100 Standards organizations.

Specific standards of the following organizations have been referenced in this subpart. Copies of the standards may be obtained from the issuing organization.

American Conference of Governmental Industrial Hygienists, 1014 Broadway, Cincinnati, OH 45202.
American National Standards Institute, 1430 Broadway, New York, NY 10018.
National Fire Protection Association, 60 Batterymarch Street, Boston, MA 02110.

### § 1910.133 Eye and face protection.

(a) *General.* (1) Protective eye and face equipment shall be required where there is a reasonable probability of injury that can be prevented by such equipment. In such cases, employers shall make conveniently available a type of protector suitable for the work to be performed, and employees shall use such protectors. No unprotected person shall knowingly be subjected to a hazardous environmental condition. Suitable eye protectors shall be provided where machines or operations present the hazard of flying objects, glare, liquids, injurious radiation, or a combination of these hazards.

(2) Protectors shall meet the following minimum requirements:

(i) They shall provide adequate protection against the particular hazards for which they are designed.

(ii) They shall be reasonably comfortable when worn under the designated conditions.

(iii) They shall fit snugly and shall not unduly interfere with the movements of the wearer.

(iv) They shall be durable.

(v) They shall be capable of being disinfected.

(vi) They shall be easily cleanable.

(vii) Protectors should be kept clean and in good repair.

(3) Persons whose vision requires the use of corrective lenses in spectacles, and who are required by this standard to wear eye protection, shall wear goggles or spectacles of one of the following types:

(i) Spectacles whose protective lenses provide optical correction.

(ii) Goggles that can be worn over corrective spectacles without disturbing the adjustment of the spectacles.

(iii) Goggles that incorporate corrective lenses mounted behind the protective lenses.

(4) Every protector shall be distinctly marked to facilitate identification only of the manufacturer.

(5) When limitations or precautions are indicated by the manufacturer, they shall be transmitted to the user and care taken to see that such limitations and precautions are strictly observed.

(6) Design, construction, testing, and use of devices for eye and face protection shall be in accordance with American National Standard for Occupational and Educational Eye and Face Protection, Z87.1-1968.

**§ 1910.135 Occupational head protection.**

Helmets for the protection of heads of occupational workers from impact and penetration from falling and flying objects and from limited electric shock and burn shall meet the requirements and specifications established in American National Standard Safety Requirements for Industrial Head Protection, Z89.1-1969.

**§ 1910.136 Occupational foot protection.**

Safety-toe footwear for employees shall meet the requirements and specifications in American National Standard for Men's Safety-Toe Footwear, Z41.1-1967.

**§ 1910.141 Sanitation.**

* * * * *

(d) *Washing facilities*—(1) *General.* Washing facilities shall be maintained in a sanitary condition.

(2) *Lavatories.* (i) Lavatories shall be made available in all places of employment in accordance with the requirements for lavatories as set forth in table J-2 of this section. In a multiple-use lavatory, 24 lineal inches of wash sink or 20 inches of a circular basin, when provided with water outlets for each space, shall be considered equivalent to one lavatory. The requirements of this subdivision do not apply to mobile crews or to normally unattended work locations if employees working at these locations have transportation readily available to nearby washing facilities which meet the other requirements of this paragraph.

TABLE J-2

| Type of employment | Number of employees | Minimum number of lavatories |
|---|---|---|
| Nonindustrial—office buildings, public buildings, and similar establishments. | 1-15 | 1. |
| | 16-35 | 2. |
| | 36-60 | 3. |
| | 61-90 | 4. |
| | 91-125 | 5. |
| | Over 125 | 1 additional fixture for each additional 45 employees. |
| Industrial—factories, warehouse, loft buildings, and similar establishments. | 1—100 | 1 fixture for each 10 employees. |
| | Over 100 | 1 fixture for each additional 15 employees. |

(ii) Each lavatory shall be provided with hot and cold running water, or tepid running water.

(iii) Hand soap or similar cleansing agents shall be provided.

(iv) Individual hand towels or sections thereof, of cloth or paper, warm air blowers or clean individual sections of continuous cloth toweling, convenient to the lavatories, shall be provided.

(v) Receptacles shall be provided for disposal of used towels.

(vi) Warm air blowers shall provide air at not less than 90° F. and shall have means to automatically prevent the discharge of air exceeding 140° F.

(vii) Electrical components of warm air blowers shall meet the requirements of Subpart S of this part.

(3) *Showers.* (i) Whenever showers are required by a particular standard, the showers shall be provided in accordance with subdivisions (ii) through (v) of the subparagraph.

(ii) One shower shall be provided for each 10 employees of each sex, or numerical fraction thereof, who are required to shower during the same shift.

(iii) Body soap or other appropriate cleansing agents convenient to the showers shall be provided as specified in paragraph (d)(2)(iii) of this section.

(iv) Showers shall be provided with hot and cold water feeding a common discharge line.

(v) Employees who use showers shall be provided with individual clean towels.

(e) *Change rooms.* Whenever employees are required by a particular standard to wear protective clothing because of the possibility of contamination with toxic materials, change rooms equipped with storage facilities for street clothes and separate storage facilities for the protective clothing shall be provided.

* * * * *

**§ 1910.145 Specifications for accident prevention signs and tags.**

* * * * *

(d) *Sign design and colors* * * *

(4) *Caution signs.* (i) Standard color of the background shall be yellow; and the panel, black with yellow letters. Any letters used against the yellow background shall be black. The colors shall be those of opaque glossy samples as specified in Table 1 of American National Standard Z53.1-1967.

**§ 1910.184 Slings.**

* * * * *

(d) *Inspections.* Each day before being used, the sling and all fastenings and attachments shall be inspected for damage or defects by a competent person designated by the employer. Additional inspections shall be performed during sling use, where service conditions warrant. Damaged or defective slings shall be immediately removed from service.

* * * * *

**Supplement II—Threshold Limit Values of Airborne Contaminants for 1970**

This is the table of "Threshold Limit Values of Airborne Contaminants for 1970" that is referenced in 29 CFR 1926.55(a). It contains administrative changes in footnotes, and it has been modified to reflect subsequent OSHA rulemakings (health standards issued pursuant to section 6(b) of the Act).

| | Substance | ppm (Note 1) | mg/M³ (Note 2) |
|---|---|---|---|
| | Abate | | 15 |
| | Acetaldehyde | 200 | 360 |
| | Acetic acid | 10 | 25 |
| | Acetic anhydride | 5 | 20 |
| | Acetone | 1,000 | 2,400 |
| | Acetonitrile | 40 | 70 |
| | Acetylene (note 3) | | |
| | Acetylene dichloride, see 1, 2-Dichloroethylene | | |
| | Acetylene tetrabromide | 1 | 14 |
| | Acrolein | 0.1 | 0.25 |
| | Acrylamide-Skin | | 0.3 |
| | Acrylonitrile—see § 1910.1045 | | |
| | Aldrin-Skin | | 0.25 |
| | Allyl alcohol-Skin | 2 | 5 |
| | Allyl chloride | 1 | 3 |
| C | Allyl glycidyl ether (AGE) | 10 | 45 |
| | Allyl propyl disulfide | 2 | 12 |
| | Alundum ($Al_2O_3$) (Note 4) | | |
| | 2-Aminoethanol, see Ethanolamine | | |
| | 2-Aminopyridine | 0.5 | 2 |
| | Ammonia | 50 | 35 |
| | Ammonium sulfamate (Ammate) | | 15 |
| | n-Amyl acetate | 100 | 525 |
| | sec-Amyl acetate | 125 | 650 |

| | Substance | ppm (Note 1) | mg/M³ (Note 2) |
|---|---|---|---|
| | Aniline-Skin | 5 | 19 |
| | Anisidine (o,p-isomers)-Skin | | 0.5 |
| | Antimony & compounds (as Sb) | | 0.5 |
| | ANTU (alpha naphthyl thiourea) | | 0.3 |
| | Argon (Note 3) | | |
| | Arsenic, and inorganic arsenic compounds except Arsine.—see § 1910.1018 | | |
| | Arsenic compounds, organic | | 0.5 |
| | Arsine | 0.05 | 0.2 |
| | Azinphos-methyl-Skin | | 0.2 |
| | Barium (soluble compounds) | | 0.5 |
| | Benzene—see § 1910.1028 | | |
| | Benzidine-Skin (Note 5) | | |
| | p-Benzoquinone, see Quinone | | |
| | Benzoyl peroxide | | 5 |
| | Benzyl chloride | 1 | 5 |
| | Beryllium | | 0.002 |
| | Biphenyl, see Diphenyl | | |
| | Bisphenol A, see Diglycidyl ether | | |
| | Boron oxide | | 15 |
| | Boron tribromide | 1 | 10 |
| C | Boron trifluoride | 1 | 3 |
| | Bromine | 0.1 | 0.7 |
| | Bromine pentafluroide | 0.1 | 0.7 |
| | Bromoform-Skin | 0.5 | 5 |
| | Butadiene (1, 3-butadiene) | 1,000 | 2,200 |
| | Butanethiol, see Butyl mercaptan | | |
| | 2-Butanone | 200 | 590 |
| | 2-Butoxy ethanol (Butyl Cellosolve)-Skin | 50 | 240 |
| | Butyl acetate (n-butyl acetate) | 150 | 710 |
| | sec-Butyl acetate | 200 | 950 |
| | tert-Butyl acetate | 200 | 950 |
| | Butyl alcohol | 100 | 300 |
| | sec-Butyl alcohol | 150 | 450 |
| | tert-Butyl alcohol | 100 | 300 |
| C | Butylamine-Skin | 5 | 15 |
| C | tert-Butyl chromate (as $CrO_3$)-Skin | | 0.1 |
| | n-Butyl glycidyl ether (BGE) | 50 | 270 |
| | Butyl mercaptan | 0.5 | 1.5 |
| | p-tert-Butyltoluene | 10 | 60 |
| | Cadmium (Metal dust and soluble salts) | | 0.2 |
| C | Cadmium oxide fume (as Cd) | | 0.1 |
| | Calcium carbonate (Note 4) | | |
| | Calcium arsenate—See § 1910.1018 | | |
| | Calcium oxide | | 5 |
| | Camphor (Synthetic) | 2 | |
| | Carbaryl (Sevin ) | | 5 |
| | Carbon black | | 3.5 |
| | Carbon dioxide | 5,000 | 9,000 |
| | Carbon disulfide-Skin | 20 | 60 |
| | Carbon monoxide | 50 | 55 |
| | Carbon tetrachloride-Skin | 10 | 65 |
| | Cellulose (paper fiber) | | |
| | Chlordan-Skin | | 0.5 |
| | Chlorinated camphene-Skin | | 0.5 |
| | Chlorinated diphenyl oxide | | 0.5 |
| | Chlorine | 1 | 3 |
| | Chlorine dioxide | 0.1 | 0.3 |
| C | Chlorine trifluoride | 0.1 | 0.4 |
| C | Chloroacetaldehyde | 1 | 3 |
| | oo-Chloroacetophenone (phenacylchloride) | 0.05 | 0.3 |
| | Chlorobenzene (monochlorobenzene) | 75 | 350 |
| | o-Chlorobenzylidene malononitrile (OCBM) | 0.05 | 0.4 |
| | Chlorobromomethane | 200 | 1,050 |
| | 2-Chloro-1, 3-butadiene, see Chloroprene | | |
| | Chlorodiphenyl (42% Chlorine)-Skin | | 1 |
| | Chlorodiphenyl (54% Chlorine)-Skin | | 0.5 |
| | 1-Chloro, 2, 3-epoxypropane, see Epichlorhydrin | | |
| | 2-Chloroethanol, see Ethylene chlorohydrin | | |
| | Chloroethylene—See § 1910.1017 | | |
| C | Chloroform (trichloromethane) | 50 | 240 |
| | 1-Chloro-1-nitropropane | 20 | 100 |
| | Chloropicrin | 0.1 | 0.7 |
| | Chloroprene (2-chloro-1, 3-butadiene) Skin | 25 | 90 |
| | Chromic acid and chromates (as $CrO_3$) | | 0.1 |
| | Chromium, sol, chromic, chromous salts as Cr | | 0.5 |
| | Metal & insol. salts | | 1 |
| | Coal tar pitch volatiles (benzene soluble fraction) anthracene, BaP phenanthrene, acridene, chrysene, pyrene) (Note 6) | | 0.2 |
| | Cobalt, metal fume & dust | | 0.1 |
| | Copper fume | | 0.1 |
| | Dusts and Mists | | 1 |
| | Corundum (Note 4) | | |
| | Cotton dust, raw—See § 1910.1043 and (Note 7) | | 1 |
| | Crag herbicide | | |
| | Cresol (all isomers)-Skin | 5 | 22 |
| | Crotonaldehyde | 2 | 6 |
| | Cumene-Skin | 50 | 245 |
| | Cyanide (as CN)-Skin | | 5 |
| | Cyanogen | 10 | |
| | Cyclohexane | 300 | 1,050 |
| | Cyclohexanol | 50 | 200 |
| | Cyclohexanone | 50 | 200 |
| | Cyclohexene | 300 | 1,015 |
| | Cyclopentadiene | 75 | 200 |
| | 2, 4-D | | 10 |
| | DDT-Skin | | 1 |
| | DDVP, see Dichlorvos | | |
| | Decaborane-Skin | 0.05 | 0.3 |
| | Eemoton-Skin | | 0.1 |
| | diacetone alcohol (4-dydroxy-4-methyl-2-pentanone) | 50 | 240 |
| | 1, 2-Diaminoethane, see Ethylene-diamine | | |
| | Diazomethane | 0.2 | 0.4 |
| | Diborane | 0.1 | 0.1 |
| C | 1, 2-Dibromoethane (ethylene dibromode)-Skin | 25 | 190 |
| | Dibutyl phosphate | 1 | 5 |
| | Dubutylphthalate | | 5 |
| C | Dichloroacteylene | 0.1 | 0.4 |
| C | o-Dichlorobenzene | 50 | 300 |
| | p-Dichlorobenzene | 75 | 450 |
| | Dichlorodifluoromethane | 1,000 | 4,950 |
| | 1,3-Dichloro-5, 5-dimethyl hydantoin | | 0.2 |
| | 1, 1-Dichloroethane | 100 | 400 |
| | 1, 2-Dichloroethane | 50 | 200 |
| | 1, 2-Dichloroethane | 200 | 790 |
| C | Dichloroethyl ether-Skin | 15 | 90 |
| | Dichloromethane, see Methylene-chloride | | |
| | Dichloromonofluoromethane | 1,000 | 4,200 |
| C | 1, 1-dichloro-1-nitroethane | 10 | 60 |
| | 1, 2-Dichloropropane, see Propylenedichloride | | |
| | Dichlorotetrafluoroethane | 1,000 | 7,000 |
| | Dichlorvos (DDVP)-Skin | | 1 |
| | Dieldrin-Skin | | 0.25 |
| | Diethylamine | 25 | 75 |
| | Diethylamino ethanol-Skin | 10 | 50 |
| C | Diethylene triamine-Skin | 10 | 42 |
| | Diethylether, see Ethyl ether | | |
| | Difluorodibromomethane | 100 | 860 |
| C | Diglycidyl ether (DGE) | 0.5 | 2.8 |
| | Dihydroxybenzene, see Hydroquinone | | |
| | Diisobutyl ketone | 50 | 290 |
| | Diisopropylamine-Skin | 5 | 20 |
| | Dimethoxymethane, see Methylal | | |
| | Dimethyl acetamide-Skin | 10 | 35 |
| | Dimethylamine | 10 | 18 |
| | Dimethylaminobenzene, see Xylidene | | |
| | Dimethylaniline (N-dimethylaniline)-Skin | 5 | 25 |
| | Dimethylbenzene, see Xylene | | |
| | Dimethyl 1, 2-dibromo-2, 2-dichloroethyl phosphate, (Dibrom) | | 3 |
| | Dimethylformamide-Skin | 10 | 30 |
| | 2, 6-Dimethylheptanone, see Diisobutyl ketone | | |
| | 1, 1-Dimethylhydrazine-Skin | 0.5 | 1 |
| | Dimethylphthalate | | 5 |
| | Dimethylsulfate-Skin | 1 | 5 |
| | Dinitrobenzene (all isomers)-Skin | | 1 |
| | Dinitro-o-cresol-Skin | | 0.2 |
| | Dinitrotoluene-Skin | | 1.5 |
| | Dioxane (Diethylene dioxide-Skin | 100 | 360 |
| | Diphenyl | 0.2 | 1 |
| | Diphenyl amine | | 10 |
| | Diphenylmethane diisocyanate (see Methylene bisphenyl isocyanate MDI) | | |
| | Dipropylene glycol methyl ether-Skin | 100 | 600 |
| | Di-sec, octyl phthalate (Di-2-ethylhexylphathalate) | | 5 |
| | Emery Note 4) | | |
| | Endosulfan (Thiodan ®)-Skin | | 0.1 |
| | Endrin-Skin | | 0.1 |
| | Epichlorhydrin-Skin | 5 | 19 |
| | EPN-Skin | | 0.5 |
| | 1, 2-Epoxypropane, see Propylene-oxide | | |
| | 2, 3-Epoxy-1-propanol, see Glycidol | | |
| | Ethane (Note 3) | | |
| | Ethanethiol, see Ethylmercaptan | | |
| | Ethanolamine | 3 | 6 |
| | 2-Ethoxyethanol-Skin | 200 | 740 |
| | 2-Ethoxyethylacetate (Cellosolve acetate)-Skin | 100 | 540 |
| | Ethyl acetate | 400 | 1,400 |
| | Ethyl acrylate-Skin | 25 | 100 |
| | Ethyl alcohol (ethanol) | 1,000 | 1,900 |
| | Ethylamine | 10 | 18 |
| | Ethyl sec-amyl ketone (5-methyl-3-heptanone) | 25 | 130 |
| | Ethyl benzene | 100 | 435 |
| | Ethyl bromide | 200 | 890 |
| | Ethyl butyl ketone (3-Heptanone) | 50 | 230 |
| | Ethyl chloride | 1,000 | 2,600 |
| | Ethyl ether | 400 | 1,200 |
| | Ethyl formate | 100 | 300 |
| | Ethyl mercaptan | 0.5 | 1 |
| | Ethyl silicate | 100 | 850 |
| | Ethylene (Note 3) | | |
| | Ethylene chlorohydrin-Skin | 5 | 16 |
| | Ethylenediamine | 10 | 25 |
| | Ethylene dibromide, see 1, 2- Dibromoethane | | |
| | Ethylene dichloride, see 1, 2- Dichloroethane | | |
| C | Ethylene glycol dinitrate and/or Nitroglycerine-Skin (Note 8) | 0.2 | |
| | Ethylene glycol monomethyl ether acetate, see Methyl cellosolve acetate | | |
| | Ethylene imine-Skin | 0.5 | 1 |
| | Ethylene oxide | 50 | 90 |
| | Ethylidine chloride, see 1, 1-Dichloroethane | | |
| | N-Ethylmorpholine-Skin | 20 | 94 |
| | Ferbam | | 15 |
| | Ferrovanadium dust | | 1 |

| Substance | ppm (Note 1) | mg/M³ (Note 2) |
|---|---|---|
| Fibrous glass (Note 5) | | |
| Fluoride (as F) | | 2.5 |
| Fluorine | 0.1 | 0.2 |
| Fluorotrichloromethane | 1,000 | 5,600 |
| C Formaldehyde | 5 | 6 |
| Formic acid | 5 | 9 |
| Furfural-Skin | 5 | 20 |
| Furfuryl alcohol | 50 | 200 |
| Gasoline (Note 9) | | |
| Glycerine mist (Note 4) | | |
| Glycidol (2, 3-Epoxy-1-propanol) | 50 | 150 |
| Glycol monoethyl ether, see 2-Ethoxyethanol | | |
| Graphite, (Synthetic) (Note 4) | | |
| Guthion,® see Azinphosmethyl | | |
| Gypsum (Note 4) | | |
| Hafnium | | 0.5 |
| Helium (Note 3) | | |
| Heptachlor-Skin | | 0.5 |
| Heptane (n-heptane) | 500 | 2,000 |
| Hexachloroethane-Skin | 1 | 10 |
| Hexachloronaphthalene-Skin | | 0.2 |
| Hexane (n-hexane) | 500 | 1,800 |
| 2-Hexanone | 100 | 410 |
| Hexone (Methyl isobutyl ketone) | 100 | 410 |
| sec-Hexyl acetate | 50 | 300 |
| Hydrazine-Skin | 1 | 1.3 |
| Hydrogen (Note 3) | | |
| Hydrogen bromide | 3 | 10 |
| C Hydrogen chloride | 5 | 7 |
| Hydrogen cyanide-Skin | 10 | 11 |
| Hydrogen fluoride | 3 | 2 |
| Hydrogen peroxide | 1 | 1.4 |
| Hydrogen selenide | 0.05 | 0.2 |
| Hydrogen sulfide | 10 | 15 |
| Hydroquinone | | 2 |
| Indene | 10 | 45 |
| Indium and compounds, as In | | 0.1 |
| C Iodine | 0.1 | 1 |
| Iron oxide fume | | 10 |
| Iron salts, soluble, as Fe | | 1 |
| Isoamyl acetate | 100 | 525 |
| Isoamyl alcohol | 100 | 360 |
| Isobuty acetate | 150 | 700 |
| Isobuty alcohol | 100 | 300 |
| Isophorone | 25 | 140 |
| Isopropyl acetate | 250 | 950 |
| Isopropyl alcohol | 400 | 980 |
| Isopropylamine | 5 | 12 |
| Isopropylether | 500 | 2,100 |
| Isopropyl glycidyl ether (IGE) | 50 | 240 |
| Kaolin (Note 4) | | |
| Ketene | 0.5 | 0.9 |
| Lead—See § 1910.1025 | | |
| Lead arsenate—See § 1910.1018 | | |
| Limestone (Note 4) | | |
| Lindane-Skin | | 0.5 |
| Lithium hydride | | 0.025 |
| L.P.G. (Liquified petroleum gas) | 1,000 | 1,800 |
| Magnesite (Note 4) | | |
| Magnesium oxide fume | | 15 |
| Malathion-Skin | | 15 |
| Maleic anhydride | 0.25 | 1 |
| C Manganese and compounds, as M | | 5 |
| Marble (Note 4) | | |
| Mercury-Skin | | 0.1 |
| Mercury (organic compounds)-Skin | | 0.01 |
| Mesityl oxide | 25 | 100 |
| Methane (Note 3) | | |
| Methanethiol, see Methyl mercaptan | | |
| Methoxychlor | | 15 |
| 2-Methoxyethanol, see Methyl cellosolve | | |
| Methyl acetate | 200 | 610 |
| Methyl acetylene (propyne) | 1,000 | 1,650 |
| Methyl acetylene-propadiene mixture (MAPP) | 1,000 | 1,800 |
| Methyl acrylate-Skin | 10 | 35 |
| Methylal (dimethoxymethane) | 1,000 | 3,100 |
| Methyl alcohol (methanol) | 200 | 260 |
| Methylamine | 10 | 12 |
| Methyl amyl alcohol, see Methyl isobutyl carbinol | | |
| Methyl isoamyl ketone | 100 | 475 |
| Methyl (n-amyl) ketone (2-Heptanone) | 100 | 465 |
| C Methyl bromide-Skin | 20 | 80 |
| Methyl butyl ketone, see 2-Hexanone | | |
| Methyl cellosolve-Skin | 25 | 80 |
| Methyl cellosolve acetate-Skin | 25 | 120 |
| C Methyl chloride | 100 | 210 |
| Methyl chloroform | 350 | 1,900 |
| Methylcyclohexane | 500 | 2,000 |
| Methylcyclohexanol | 100 | 470 |
| o-Methylcyclohezanone-Skin | 100 | 460 |
| Methyl ethyl ketone(MEK), see 2-Butanone | | |
| Methyl formate | 100 | 250 |
| Methyl iodide-Skin | 5 | 28 |
| Methyl isobutyl carbinol-Skin | 25 | 100 |
| Methyl isobutyl ketone, seeHexone | | |
| Methyl isocyanate - Skin | 0.02 | 0.05 |
| Methy mercaptan | 0.5 | 1 |
| Methyl methacrylat | 100 | 410 |
| Methyl propyl ketone,see 2-Pentanone | | |
| C Methyl silicate | 5 | 30 |
| C Methyl styrene | 100 | 480 |
| C Methylene bisphenyl isocyanate (MDI) | 0.02 | 0.2 |
| Methylene chloride (dichloromethane) | 500 | 1,740 |
| Molybdenum (soluble compounds) | | 5 |
| (insoluble compounds) | | 15 |
| Monomethyl aniline-Skin | 2 | 9 |
| C Monomethyl hydrazine-Skin | 0.2 | 0.35 |
| Morpholine-Skin | 20 | 70 |
| Naphtha (coal tar) | 100 | 400 |
| Naphthalene | 10 | 50 |
| beta-Naphthylamine (Note 5) | | |
| Neon (Note 3) | | |
| Nickel carbonyl | 0.001 | 0.007 |
| Nickel, metal and soluble cmpds, as Ni | | 1 |
| Nicotine-Skin | | 0.5 |
| Nitric acid | 2 | 5 |
| Nitric oxide | 25 | 30 |
| p-Nitroaniline-Skin | 1 | 6 |
| Nitrobenzene-Skin | 1 | 5 |
| p-Nitrochlorobenzene-Skin | | 1 |
| Nitroethane | 100 | 310 |
| Nitrogen (Note 3) | | |
| C Nitrogen dioxide | 5 | 9 |
| Nitrogen trifluoride | 10 | 29 |
| Nitroglycerin-Skin | 0.2 | 2 |
| Nitromethane | 100 | 250 |
| 1-Nitropropane | 25 | 90 |
| 2-Nitropropane | 25 | 90 |
| N-Nitrosodimethylamine (dimethylnitrosamine)-Skin (Note 5) | | |
| Nitrotoluene-Skin | 5 | 30 |
| Nitrotrichloromethane, see Chloropicrin | | |
| Nitrous oxide (Note 3) | | |
| Octachloronaphthalene-Skin | | 0.1 |
| Octane | 400 | 1,900 |
| Oil mist, particulate (Note 10) | | |
| Oil mist, vapor (Note 11) | | |
| Osmium tetroxide | | 0.002 |
| Oxalic acid | | 1 |
| Oxygen difluoride | 0.05 | 0.1 |
| Ozone | 0.1 | 0.2 |
| Paraquat-Skin | | 0.5 |
| Parathion-Skin | | 0.1 |
| Pentaborane | 0.005 | 0.01 |
| Pentachloronaphthalene-Skin | | 0.5 |
| Pentachlorophenol-Skin | | 0.5 |
| Pentaerythritol (Note 4) | | |
| Pentane | 500 | 1,500 |
| 2-Pentanone | 200 | 700 |
| Perchloroethylene | 100 | 670 |
| Perchloromethyl mercaptan | 0.1 | 0.8 |
| Perchloryl fluoride | 3 | 13.5 |
| Petroleum distillates (naphtha) (Note 11) | | |
| Phenol-Skin | 5 | 19 |
| p-Phenylene diamine-Skin | | 0.1 |
| Phenyl ether (vapor) | 1 | 7 |
| Phenyl ether-Biphenyl mixture (vapor) | 1 | 7 |
| Phenylethylene, see Styrene | | |
| Phenyl glycidyl ether (PGE) | 10 | 60 |
| Phenylhydrazine-Skin | 5 | 22 |
| Phosdrin (Mevinphos®)-Skin | | 0.1 |
| Phosgene (carbonyl chloride) | 0.1 | 0.4 |
| Phosphine | 0.3 | 0.4 |
| Phosphoric acid | | 1 |
| Phosphorus (yellow) | | 0.1 |
| Phosphorus pentachloride | | 1 |
| Phosphorus pentasulfide | | 1 |
| Phosphorus trichloride | 0.5 | 3 |
| Phthalic anhydride | 2 | 12 |
| Picric acid-Skin | | 0.1 |
| Pival ® (2-Pivalyl-1, 3-indandione) | | 0.1 |
| Plaster of Paris (Note 4) | | |
| Platinum (Soluble Salts) as Pt | | 0.002 |
| Polytetrafluoroethylene decomposition products (Note 12) | | |
| Propane (Note 3) | | |
| beta-Propiolactone (Note 5) | | |
| Propargyl alcohol-Skin | 1 | |
| n-Propyl acetate | 200 | 840 |
| Propyl alcohol | 200 | 500 |
| n-Propyl nitrate | 25 | 110 |
| Propylene dichloride | 75 | 350 |
| Propylene imine-Skin | 2 | 5 |
| Propylene oxide | 100 | 240 |
| Propyne, see Methylacetylene | | |
| Pyrethrum | | 5 |
| Pyridine | 5 | 15 |
| Quinone | 0.1 | 0.4 |
| RDX-Skin | | 1.5 |
| Rhodium, Metal fume and dusts, as Rh | | 0.1 |
| Soluble salts | | 0.001 |
| Ronnel | | 10 |
| Rotenone (commercial) | | 5 |
| Rouge (Note 4) | | |
| Selenium compounds (as Se) | | 0.2 |
| Selenium hexafluoride | 0.05 | 0.4 |
| Silicon carbide (Note 4) | | |
| Silver, metal and soluble compounds | | 0.01 |
| Sodium fluoroacetate (1080)-Skin | | 0.05 |
| Sodium hydroxide | | 2 |
| Stibine | 0.1 | 0.5 |
| Starch (Note 4) | | |
| Stoddard solvent | 200 | 1,150 |
| Strychnine | | 0.15 |
| C Styrene monomer (phenylethylene) | 100 | 420 |
| Sucrose (Note 4) | | |
| Sulfur dioxide | 5 | 13 |
| Sulfur hexafluoride | 1,000 | 6,000 |
| Sulfuric acid | | 1 |
| Sulfur monochloride | 1 | 6 |
| Sulfur pentafluoride | 0.025 | 0.25 |
| Sulfuryl fluoride | 5 | 20 |
| Systox, see Demeton® | | |
| Tantalum | | 5 |
| TEDP-Skin | | 0.2 |
| Teflon® decomposition products (Note 12) | | |

| | Substance | ppm (Note 1) | mg/M³ (Note 2) |
|---|---|---|---|
| | Tellurium | | 0.1 |
| | Tellurium hexafluoride | 0.02 | 0.2 |
| | TEPP-Skin | | 0.05 |
| C | Terphenyls | 1 | 9 |
| | 1, 1, 1, 2-Tetrachloro-2, 2-difluoroethane | 500 | 4,170 |
| | 1, 1, 2, 2-Tetrachloro-1, 2-difluoroethane | 500 | 4,170 |
| | 1, 1, 2, 2-Tetrachloroethane-Skin | 5 | 35 |
| | Tetrachloroethylene, see Perchloroethylene | | |
| | Tetrachloromethane, see Carbon tetrachloride | | |
| | Tetrachloronaphthalene-Skin | | 2 |
| | Tetraethyl lead (as Pb)-Skin (Note 13) | | |
| | Tetrahydrofuran | 200 | 590 |
| | Tetrametyl lead (as Pb)-Skin (Note 13) | | |
| | Tetramethyl succinonitrile-Skin | 0.5 | 3 |
| | Tetranitromethane | 1 | 8 |
| | Tetryl (2, 4, 6-trinitrophenyl-methylnitramine)-Skin | | 1.5 |
| | Thallium (soluble compounds)-Skin as Tl | | 0.1 |
| | Thiram | | 5 |
| | Tin (inorganic cmpds, except $SnH_4$ and $SnO_2$) | | 2 |
| | Tin (organic cmpds) | | 0.1 |
| | Tin oxide (Note 4) | | |
| | Titanium dioxide (Note 4) | | |
| | Toluene (toluol) | 200 | 750 |
| C | Toluene-2, 4-diisocyanate | 0.02 | 0.14 |
| | o-Toluidine-Skin | 5 | 22 |
| | Toxaphene, see Chlorinated camphene | | |
| | Tributyl phosphate | | 5 |
| | 1, 1, 1-Trichloroethane, see Methyl chloroform | | |
| | 1, 1, 2-Trichloroethane-Skin | 10 | 45 |
| | Trichloroethylene | 100 | 535 |
| | Trichloromethane, see Chloroform | | |
| | Trichloronaphthalene-Skin | | 5 |
| | 1, 2, 3-Trichloropropane | 50 | 300 |
| | 1, 1, 2-Trichloro 1, 2, 2-trifluoroethane | 1,000 | 7,600 |
| | Triethylamine | 25 | 100 |
| | Trifluoromonobromomethane | 1,000 | 6,100 |
| | Trimethyl benzene | 25 | 120 |
| | 2, 4, 6-Trinitrophenol, see Picric acid | | |
| | 2, 4, 6-Trinitrophenyl-methylnitramine, see Tetryl | | |
| | Trinitrotoluene-Skin | | 1.5 |
| | Triorthocresyl phosphate | | 0.1 |
| | Triphenyl phosphate | | 3 |
| | Tungsten & compounds, as W | | |
| | Soluble | | 1 |
| | Insoluble | | 5 |
| | Turpentine | 100 | 560 |
| | Uranium (natural) sol. & insol. compounds as U | | 0.2 |
| C | Vanadium ($V_2O_5$ dust) | | 0.5 |
| | ($V_2O_5$ fume) | | 0.1 |
| | Vinyl benzene, see Styrene | | |
| | Vinyl chloride—See § 1910.1017 | | |
| | Vinylcyanide, see Acrylonitrile | | |
| | Vinyl toluene | 100 | 480 |
| | Warfarin | | 0.1 |
| | Xylene (xylol) | 100 | 435 |
| | Xylidine-Skin | 5 | 25 |
| | Yttrium | | 1 |
| | Zinc chloride fume | | 1 |
| | Zinc oxide fume | | 5 |
| | Zirconium compounds (as Zr) | | 5 |

## Mineral Dusts

| Substance | m.p.p.c.f. (Note 14) |
|---|---|
| SILICA | |
| Crystalline | |
| Quartz, Threshold Limit calculated from the formula | 250 |
| | %$SiO_2$+5 (Note 15) |
| Cristobalite " " " | |
| Amorphous, including natural diatomaceous earth | 20 |
| SILICATES (less than 1% crystalline silica) | |
| Asbestos—See § 1910.1001 | |
| Mica | 20 |
| Portland Cement | 50 |
| Soapstone | 20 |
| Talc (non-asbestiform) | 20 |
| Talc (fibrous), use asbestos limit | |
| Tremolite, see asbestos | |
| Graphite (natural) | 15 |
| "Inert" or Nuisance Particulates | 50 (or 15 mg/M³ whichever is the smaller) of total dust <1% $SiO_2$ |

Conversion factors

mppcf×35.3 = million particles per cubic meter = particles per c.c.

## Table Notes

(1) Parts of vapor or gas per million parts of contaminated air by volume at 25°C and 760 mm. Hg pressure.

(2) Approximate milligrams of particulate per cubic meter of air.

(3) Simple asphxyiant—See 1970 Threshold Limit Value pamphlet, Preface and Appendix E.

(4) "Nuisance" or "Inert" dust—See Mineral Dusts table and 1970 Threshold Limit Value pamphlet, Preface and Appendix D.

(5) Carcinogen—See Threshold Limit Value pamphlet, Appendix A[1].

(6) Not applicable to coke oven emissions; see § 1910.1029.

(7) The standard of 1 mg/m³ applies in cotton yarn manufacturing until compliance with § 1910.1043 is achieved.

(8) An atmospheric concentration of not more than 0.02 ppm, or personal protection may be necessary to avoid headache.

(9) Substance has variable composition—see Threshold Limit Value pamphlet Appendix A[3] to determine Threshold Limit Value.

(10) As sampled by method that does not collect vapor.

(11) According to analytically determined composition. See 1970 Threshold Limit Value pamphlet Appendix A[3] to determine Threshold Limit Value.

(12) See 1970 Threshold Limit Value pamphlet Appendix A[2].

(13) For control of general room air, biologic monitoring is essential for personnel control.

(14) Millions of particles per cubic foot of air, based on impinger samples counted by light-field technics.

(15) The percentage of crystalline silica in the formula is the amount determined from airborne samples, except in those instances in which other methods have been shown to be applicable.

**Supplement III—List of Standards (Other Federal Agency, ANSI, NEC, NFPA, etc.) Incorporated by Reference in Part 1926 and Those Part 1910 Standards Identified as Applicable to Construction Work**

### Private Standards Setting Organizations

ACGIH AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS

1970 THRESHOLD LIMIT VALUES OF AIRBORNE CONTAMINANTS

ANSI AMERICAN NATIONAL STANDARDS INSTITUTE, INC.

A10.3-1970 Explosive-Actuated Fastening Tools, Safety Requirements for
A10.4-1963 Workmen's Hoists, Safety Requirements for
A10.5-1969 Material Hoists, Safety Requirements for
A10.9-1970 Concrete Construction and Masonry Work, Safety Requirements for
A11.1-1965 (R1970) Industrial Lighting, Practices for (IES RP7-1965)
A14.1-1968 Portable Wood Ladders, Safety Code for
A14.2-1956 Portable Metal Ladders, Safety Code for
A14.3-1956 Fixed Ladders, Safety Code for
A17.1-1965 Elevators, Dumbwaiters and Moving Walks, Safety Code for
A17.1a-1967 Supplement to A17.1-1965
A17.1b-1968 Supplement to A17.1-1965 and A17.1a-1967
A17.1c-1969 Supplement to A17.1-1965, A17.1a-1967, and A17.1b-1968
A17.1d-1970 Supplement to A17.1-1965, A17.1a-1967, and A17.1b-1968 and A17.1c-1969
A17.2-1960 Elevators, Practice for the Inspection of (Inspector's Manual)
A17.2a-1965 Addenda to A17.2-1960
A17.2b-1967 Supplement to A17.2-1960
A92.2-1969 Vehicle Mounted Elevating and Rotating Work Platforms
A120.1-1970 Power-Operated Platforms Used for Exterior Building Maintenance, Safety Code for
B7.1-1970 Use, Care and Protection of abrasive Wheels, Safety Code for the
B15.1-1953 (R1958) Mechanical Power-Transmission Apparatus, Safety Code for
B20.1-1957 Conveyors, Cableways, and Related Equipment, Safety Code for
B30.2.0-1967 Overhead and Gantry Cranes, Safety Code for (Partial Revision of B30.2-1943)
B30.5-1968 Crawler, Locomotive and Truck Cranes, Safety Code for (Partial Revision of B30.2-1943)
B30.6-1969 Derricks, Safety Code for (Partial Revision of B30.2-1943)
B56.1-1969 Powered Industrial Trucks, Safety Standards for (ISO R1074)
D6.1-1971 Manual on Uniform Traffic Control Devices for Streets and Highways
J6.6-1971 Rubber Insulating Gloves
J6.7-1935 (R1971) Rubber Matting for Use Around Electrical Apparatus
J6.4-1971 Rubber Insulating Blankets
J6.2-1950 (R1971) Rubber Insulating Hoods
J6.1-1950 (R1971) Rubber Insulating Line Hose
J6.5-1971 Rubber Insulating Sleeves
01.1-1961 Woodworking Machinery, Safety Code for

Z35.1-1968 Accident Prevention Signs, Specifications for
Z35.2-1968 Accident Prevention Tags, Specifications for
Z49.1-1967 Welding and Cutting, Safety in
Z87.1-1968 Occupational and Educational Eye and Face Protection, Practice for (Partial Revision of Z2.1-1959)
Z89.1-1969 Industrial Head Protection, Safety Requirements for
Z89.2-1971 Industrial Protective Helmets for Electrical Workers, Class B, Safety Requirements for

AMERICAN RED CROSS (INSTRUCTION IN FIRST AID)

ASAE AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

ASAE R313 SOIL CONE PENETROMETER, 1971

ASME AMERICAN SOCIETY OF MECHANICAL ENGINEERS

AMERICAN WELDING SOCIETY

AWS B3.0-41
AWS D8.4-61
AWS D10.9-69
AWS D2.0-69
Power Boilers (Section I), 1968
Pressure Vessels (Section VIII), 1968

ASTM AMERICAN SOCIETY FOR TESTING AND MATERIALS

A370-68 Mechanical Testing of Steel Products, Standard Methods and Definitions for
B117-64 (50-hour test)
D56-69 Flash Point by the Tag Closed Tester, Standard Method of Test for
D93-69 Flash Point by the Pensky-Martens Closed Tester, Standard Method of Test for
D323-58 (R-68) Vapor Pressure of Petroleum Products (Reid Method), Standard Method of Test for

FACTORY MUTUAL ENGINEERING CORP.

IME INSTITUTE OF MAKERS OF EXPLOSIVES

Publication No. 2, June 5, 1964, American Table of Distances for Storage of Explosives
Publication No. 20, March 1968, Radio Frequency Energy—A Potential Hazard in the Use of Electric Blasting Caps

NFPA NATIONAL FIRE PROTECTION ASSOCIATION

NOTE: The National Electrical Code may be found in both ANSI and NFPA standards. Although, in this listing, reference is made to the standard under both ANSI and NFPA, only one source need be maintained.
NFPA 100-1970 Recommended Good Practice for the Maintenance and Use of Portable Fire Extinguishers
NFPA 13-1969 Installation of Sprinkler Systems, Standards for the
NFPA 30-1969 Flammable and Combustible Liquid Code, Chapters III and IV
NFPA 70-1971 National Electrical Code (ANSI C1-1971)*
NFPA 80-1970 Fire Doors and Windows, Standards for
NFPA 251-1969 Fire Tests of Building Construction and Materials, Standard Methods of
NFPA 385-1966 Recommended Regulatory Standards for Tank Vehicles and Flammable and Combustible Liquids

PCSA POWER CRANE AND SHOVEL ASSOCIATION

Standard No. 1-1968 Mobile Power Crane and Excavator Standards
Standard No. 2-1968 Mobile Hydraulic Crane Standards
Standard No. 3-1968 Mobile Hydraulic Excavator Standards

SAE SOCIETY OF AUTOMOTIVE ENGINEERS

SAE Handbook—1971
SAE Handbook—1970, pages 1088-1103 (Nomenclature and Descriptions)
SAE J166-1971 Minimum Performance Criteria for Brake Systems for Off-Highway Trucks and Wagons
SAE J167-1971 Protective Frame With Overhead Protection—Test Procedures and Performance Requirements
SAE J168 (July 1970) Protective Enclosures—Test Procedures and Performance Requirements
SAE J236-1971 Minimum Performance Criteria for Brake Systems for Rubber-Tired, Self-Propelled Graders
SAE J237-1971 Minimum Performance Criteria for Brake Systems for Off-Highway, Rubber-Tired, Front End Loaders and Dozers
SAE J319b-1971 Minimum Performance Criteria for Brake Systems for Off-Highway, Rubber-Tired, Self-Propelled Scrapers
SAE J320a-1971 Minimum Performance Criteria for Roll-Over Protective Structures for Rubber-Tired, Self-Propelled Scrapers
SAE J321a-1970 Fenders for Pneumatic-Tired Earthmoving Haulage Equipment
SAE J333a-1970 Operation Protection for Wheel-Type Agricultural and Industrial Tractors
SAE J334a-1970 Protective Frame Tests Procedures and Performance Requirements
SAE J386-1969 Seat Belts for Construction Equipment
SAE J394-1971 Minimum Performance Criteria for Roll-Over Protective Structure for Rubber-Tired Front End Loaders and Rubber-Tired Dozers
SAE J395-1971 Minimum Performance Criteria for roll-Over Protective Structure Crawler Tractors and Crawler-Type Loaders
SAE J396-1971 Minimum Performance Criteria for Roll-Over Protective Structure for Motor Graders
SAE J397-1969 Critical Zone-Characteristics and Dimensions for Operators of Construction and Industrial Machinery
SAE J743a-1964 Tractor Mounted Side Boom
SAE J959-1966 Lifting Crane, Wire-Rope Strength Factors

UNDERWRITERS LABORATORIES, INC.

FEDERAL AGENCIES

ATOMIC ENERGY COMMISSION (NOW DEPARTMENT OF ENERGY)

10 CFR Part 20, Protection Against Radiation, Standards for Bureau of Mines (Department of Interior) (now Mine Safety & Health Administration, Department of Labor)
30 CFR Part 32, Mobile Diesel Power Equipment for Non-Coal Mines, Schedule 24—March 23, 1965

BUREAU OF RECLAMATION (DEPARTMENT OF INTERIOR)

Safety and Health Regulations for Construction, Part II (September 1971)

GENERAL SERVICES ADMINISTRATION

QQ-P-416 Federal Specification, Plating, Cadmium (Electrodeposited)

INTERNAL REVENUE SERVICE (DEPARTMENT OF THE TREASURY)

20 CFR Part 181, Commerce in Explosives

NATIONAL BUREAU OF STANDARDS (DEPARTMENT OF COMMERCE)

PS 1-66 American Plywood Association, 1966
PS 20-70 American Softwood Lumber Association, 1970

OCCUPATIOAL SAFETY AND HEALTH ADMINISTRATION (DEPARTMENT OF LABOR)

29 CFR Part 1915 Safety & Health regulations for Ship Repairing
29 CFR Part 1916 Safety & Health regulations for Shipbuilding
29 CFR Part 1918 Safety & Health regulations for Longshoring

TRANSPORTATION, DEPARTMENT OF

49 CFR Part 171-179 Highways and Railroads
49 CFR Part 180 Pipelines
49 CFR Part 192 Gas Pipelines
49 CFR Part 390-397 Motor Carriers
49 CFR Part 571 Motor Vehicle Safety Standards
46 CFR Part 146-148 Water Carriers
14 CFR Part 103 Air Transportation

U.S. COAST GUARD

U.S. ARMY CORPS OF ENGINEERS

EM-385-1-1 (March 1967) General Safety Requirements

OTHER GOVERNMENTAL AGENCIES

State of California: Construction Safety Orders
Department of Industrial Relations; Division 5, Labor Code, Section 6312, State of California

---

**Supplement IV—Addresses and Telephone Numbers (Where Appropriate) of Federal Agencies, Private Organizations, and Other Sources of Standards Referenced in OSHA Standards Applicable to Construction Work**

STANDARDS ORGANIZATIONS

ACGIH American Conference Governmental Industrial Hygienists, 2205 South Road, Cincinnati, Ohio 45238, Telephone: 513-941-6332.
ANSI American National Standards Institute, Inc., 1430 Broadway, New York, N.Y. 10018, Telephone: 212-354-3300.
ASAE American Society of Agricultural Engineers, 2950 Niles Avenue, P.O. Box 410, St. Joseph, Mich. 49085, Telephone: 616-429-0300.
ASME American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, N.Y. 10017, Telephone: 212-644-7722.
ASTM American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103, Telephone: 215-299-5400.

IME Institute of Makers of Explosives, 420 Lexington Avenue, New York, N.Y. 10017, Telephone: 212-986-6920.

NFPA National Fire Protection Association, 470 Atlantic Avenue, Boston, Mass. 02110, Telephone: 617-482-8755.

State of California, Departments of Industrial Relations; Division 5, Labor Code, Section 6312, State of California, 455 Golden Gate, San Francisco, Calif. 94102, Telephone: 415-557-2037.

The American National Red Cross, 17 Street, between D and E Streets NW., Washington, D.C. 20006, Telephone: 202-737-8300.

APA American Plywood Association, Room 203, 4121 Chatelain Road, Annandale, Va. 22003, Telephone: 703-750-3993.

AWS American Welding Society, 2501 Northwest 7th Street, Miami, Fla. 33125, Telephone: 305-642-7090.

FM Factory Mutual Engineering Research Corp., 1151 Boston Providence Highway, Norwood, Mass. 02062, Telephone: 617-762-4300.

PCSA Power Crane and Shovel Association, Suite 1700, Marine Plaza, 111 East Wisconsin Avenue, Milwaukee, Wis. 53202, Telephone: 414-272-0943.

SAE Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pa. 15096, Telephone: 412-776-4841.

UL Underwriters' Laboratories, Inc., 207 East Ohio Street, Chicago, Ill. 60611, Telephone: 312-642-6969.

FEDERAL AGENCIES

AEC Atomic Energy Commission (now defunct). Functions absorbed in Department of Energy, 20 Massachusetts Avenue NW., Washington, D.C. 20545, Telephone: 202-252-5000 and Nuclear Regulatory Commission, Washington, D.C. 20555, Telephone: 202-492-7000.

BOM Bureau of Mines, Department of the Interior, 2401 E Street NW., Washington, D.C. 20241, Telephone: 202-634-1001. (Functions absorbed by the U.S. Department of Labor, Mine Safety and Health Administration.)

BuRec Bureau of Reclamation, Department of the Interior, C Street between 18th and 19th Streets NW., Washington, D.C. 20240, Telephone: 202-343-4662.

COE U.S. Army Corps of Engineers, Department of the Army, Office of the Chief of Engineers, Washington, D.C. 20314, Telephone: 202-693-6456.

DOT Department of Transportation, 400 Seventh Street SW., Washington, D.C. 20590, Telephone: 202-426-4000.

FAA Federal Aviation Administration, Department of Transportation, 800 Independence Avenue SW., Washington, D.C. 20591, Telephone: 202-426-4000.

GSA General Services Administration, 18th and F Streets NW., Washington, D.C. 20405, Telephone: 202-472-1082.

IRS Internal Revenue Service, Department of the Treasury, 15th Street and Pennsylvania Avenue NW., Washington, D.C. 20220, Telephone: 202-566-2000.

MSHA U.S. Department of Labor, Mine Safety and Health Administration, 4015 Wilson Boulevard, Room 516, Arlington, Va. 22203, Telephone: 703-235-8647.

NIOSH National Institute for Occupational Safety and Health, 5600 Fishers Lane, Rockville, Md. 20857, Telephone: 301-443-1646.

OSHA Occupational Safety and Health Administration, Department of Labor, 200 Constitution Avenue NW., Washington, D.C. 20210, Telephone: 202-523-8165.

USCG U.S. Coast Guard, Department of Transportation, 400 Seventh Street SW., Washington, D.C. 20590, Telephone: 202-426-4000.

**Any referenced documents which have been updated and the specific referenced standard is not currently available from the source may be reviewed and copied at all OSHA Regional and Area Offices.

[FR Doc. 79-4608 Filed 2-8-79; 8:45 am]